Chapter 6
Groundwater Resources

The use and sustainable management of groundwater resources is a crucial component in meeting the increasing water demands throughout the State of California, and groundwater resources north and south of the Delta provide a variety of acquisition options for the EWA Project Agencies. These options substantially enhance the operational flexibility of the EWA asset acquisition strategies. This chapter describes the groundwater resources in the Program area, presents the EWA Project Agencies' groundwater purchasing process, and discusses potential groundwater effects.

6.1 Affected Environment/Existing Conditions

This section introduces the boundaries of the area of analysis (Section 6.1.1), provides the regulatory setting pertaining to groundwater resources in the analysis area (Section 6.1.2), and describes the groundwater basins within the area of analysis (Sections 6.1.3 – Section 6.1.5). Information specific to the area of analysis includes regional information on the hydrology; groundwater production, levels, and storage; land subsidence; and groundwater quality. Section 6.2.4, Environmental Consequences/Environmental Impacts of the Flexible Purchase Alternative, provides more specific information relating to the potential effects within the agencies that may provide EWA Project Agencies with assets through groundwater transfers.

6.1.1 Area of Analysis

The groundwater resources area of analysis extends from the City of Redding in the northern portion of the Sacramento Valley to Kern County in the southern portion of the San Joaquin Valley. The area of analysis consists of the following groundwater basins:

- Redding Groundwater Basin
- Sacramento Groundwater Basin
- North San Joaquin Groundwater Basin
- South San Joaquin Groundwater Basin

Figure 6-1 shows the boundaries of the area of analysis and the groundwater basins. Groundwater transfers to the EWA Program could be made by selling agencies that are within these groundwater basins. The locations of the selling agencies (listed in Tables 2-5 and 2-9) are given in subsequent figures in the following sections. The groundwater area of analysis does not include all areas within the EWA Area, including the northern and southern areas outside of the Central Valley groundwater basins.

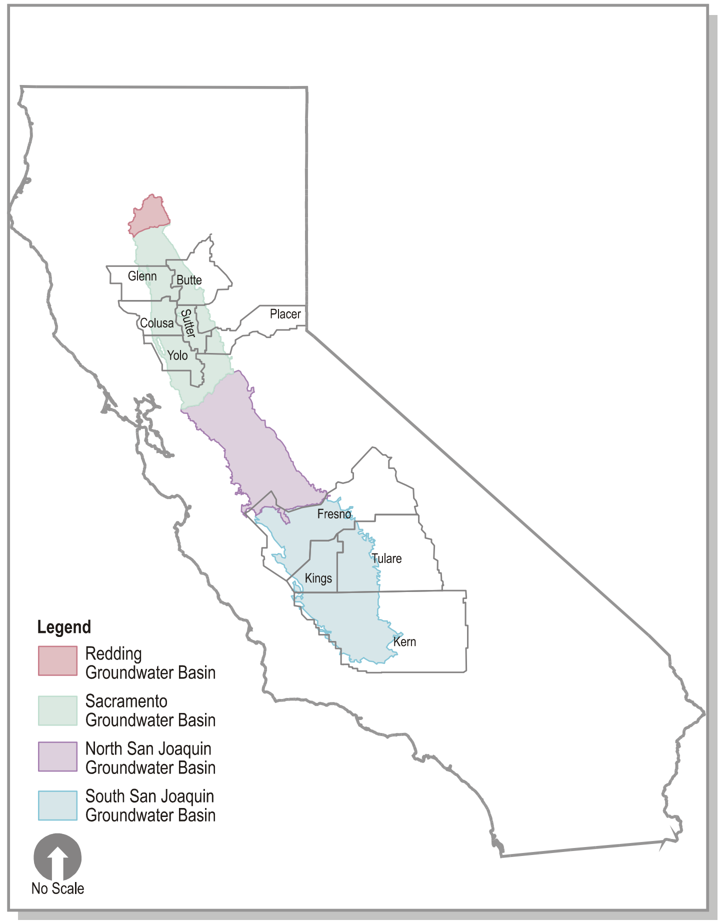


Figure 6-1
Groundwater Resources Area of Analysis

6.1.2 Regulations Affecting Water Purchases

EWA Project Agency acquisitions of groundwater would come from willing sellers, who are to comply with applicable regulations: State regulations; Central Valley Project (CVP) and State Water Project (SWP) contractual requirements; and local regulations, as described below.

6.1.2.1 State Regulation

Groundwater use is subject to limited statewide regulation; however, all water use in California is subject to constitutional provisions that prohibit waste and unreasonable use of water (SWRCB 1999). In general, groundwater and groundwater-related transfers are subject to a number of provisions in the Water Code. These provisions require compliance with: 1) local groundwater management plans, 2) the "no injury" rule[1], and 3) Section 1220 that regulates the direct export of groundwater from the combined Sacramento and Delta-Central Sierra Basins.

---

1 The "no injury" rule refers collectively to Sections 1702, 1706, 1727, 1736, and 1810 of the Water Code.

The State Water Code (Section 1745.10) requires that for water transfers pursuant to Sections 1725[2] and 1735[3], the transferred water may not be replaced with groundwater unless the following criteria are met (SWRCB 1999):

- The transfer is consistent with applicable groundwater management plans; or
- The transferring water supplier approves the transfer and, in the absence of a groundwater management plan, determines that the transfer will not create, or contribute to, conditions of long-term overdraft in the groundwater basin.

In addition to these requirements, State well standards and local ordinances govern well placement, and the Water Code requires submission of well completion reports. Any groundwater transfers involving construction of new wells would be subject to these regulations, as well as other applicable local regulations and ordinances.

The "no injury" provisions of the Water Code provide that transfers cannot cause "injury to any legal user of the water involved." Groundwater users are protected by the provisions as long as they are legal users of water. The "no-injury" rules typically apply to legal third parties. Although not defined in the Water Code, third parties are typically not the entities conducting the transfer or receiving the transferred water, but are the parties (including Indian tribes) that could be affected by the transfers.

Other groundwater regulation is related primarily to water quality issues, which are addressed through a number of different legislative acts and are the responsibility of several different State agencies including:

- **The State Water Resource Control Board (SWRCB) and nine regional water quality control boards** - responsible for protecting water quality for present and future beneficial use;
- **The Department of Toxic Substances Control** - responsible for protecting public health from improper handling, storage, transport, and disposal of hazardous materials;
- **The Department of Pesticide Regulation** - responsible for preventing pesticide pollution of groundwater;
- **The Department of Health Services** - responsible for drinking water supplies and standards;

---

[2] Section 1725 of the Water Code pertains to short-term/temporary transfers of water under post 1914 water rights that involve the amount of water that would have been consumptively used or stored by the transferee in the absence of the change or transfer. Such changes or transfers are exempt from CEQA, but require findings of "no injury to other legal users" and "no unreasonable effects on fish and wildlife".

[3] Section 1735 of the Water Code pertains to long-term transfers of water or water rights involving a change of point of diversion, place of use, or purpose of use. A transfer is considered long-term if it exceeds a period of one year.

- **The California Integrated Waste Management Board** - oversees non-hazardous solid waste disposal, and

- **The Department of Conservation** - responsible for preventing groundwater contamination due to oil, gas, and geothermal drilling and related activities.

Assembly Bill 3030 (AB3030), Water Code Section 10750 (commonly referred to as the Groundwater Management Act) permitted local agencies to develop groundwater management plans that covered certain aspects of management. Subsequent legislation has amended this chapter to make the adoption of a management program mandatory if an agency is to receive public funding for groundwater projects, creating an incentive and implementation of plans. The following section provides more detail on AB3030.

Senate Bill 1938 (SB 1938), Water Code Section 10753.7, requires local agencies seeking State funds for groundwater construction or groundwater quality projects are required to have the following: 1) a developed and implemented groundwater management plan that includes basin management objectives[4] (BMOs) and addresses the monitoring and management of groundwater levels, groundwater quality degradation, inelastic land subsidence, and surface water/groundwater interaction; 2) a plan addressing cooperation and working relationships with other public entities; 3) a map showing the groundwater subbasin the project is in, neighboring local agencies, and the area subject to the groundwater management plan; 4) protocols for the monitoring of groundwater levels, groundwater quality, inelastic land subsidence, and groundwater/surface water interaction; and 5) groundwater management plans with the components listed above for local agencies outside the delineated Bulletin 118 groundwater subbasins.

The Monterey Amendments to SWP contacts enhance management of SWP supplies and operations. This amendment established a number of water management tools including:

- **Turnback pool –** SWP contractors may sell unneeded SWP Table A allocated water through a "turnback pool" to other contractors.

- **Water Transfers –** Subject to DWR approval, SWP contractors may permanently transfer Table A amounts to other SWP contactors.

- **Storage outside the service area –** SWP contractors may store water outside of their service areas for use in their SWP service area at a later date. As discussed in Section 6.1.5.3, Semitropic Irrigation District (ID), Arvin-Edison Water Storage District (WSD), and other groundwater banks in Kern County provide

---

[4] BMOs are a management strategy designed to define the acceptable range of groundwater levels, groundwater quality, and inelastic land subsidence that can occur in a local area without causing significant adverse impacts.

groundwater storage services, allowing other districts to bank water in their service areas.

6.1.2.2 Local Regulation

Local groundwater management plans and county ordinances vary by authority/agency and region, but typically involve provisions to limit or prevent groundwater overdraft, regulate transfers, and protect groundwater quality. AB3030, the Groundwater Management Act, encourages local water agencies to establish local Groundwater Management Plans and the act lists 12 elements that should be included within the plans to ensure efficient use, good groundwater quality, and safe production of water. These 12 elements may include (State Water Code, Section 10753):

- Control of saline water intrusion;
- Identification and management of well head protection areas and recharge areas;
- Regulation of the migration of contaminated groundwater;
- Administration of a well abandonment and destruction program;
- Mitigation of conditions of overdraft;
- Replenishment of groundwater extracted by water producers;
- Monitoring of groundwater levels and storage;
- Facilitation of conjunctive use operations;
- Identification of well construction policies;
- Construction and operation (by the local agency) of groundwater contamination cleanup, recharge, storage, conservation, water recycling, and extraction projects;
- Development of relationships with State and Federal regulatory agencies; and
- Review of land use plans and coordination with land use planning agencies to assess activities that create a reasonable risk of groundwater contamination.

Table 6-1 lists the current groundwater management plans, agreements, and county ordinances that apply to agencies that may sell water to the EWA Program. These plans are discussed in further detail in Section 6.2.4**.** Table 6-2 lists the AB3030 plan components (outlined in the Water Code Section 10750) that are included in the groundwater management plan for potential EWA willing sellers.

Local Tribal groundwater ordinances and policies may also play a role in groundwater transfers to the EWA. These local ordinances would be addressed during a consultation process prior to the EWA transfers, if adverse groundwater effects were anticipated. (See Section 21.3.1 for further details.)

Table 6-1
Local Groundwater Management Plans and Ordinances

Groundwater Basin	***Potential EWA Willing Sellers***	***Groundwater Management Plans, Agreements and County Ordinances***
Redding	Anderson-Cottonwood ID	• Shasta County Ordinance No. SCC 98-1 • Tehama County Urgency Ordinance No. 1617 • Tehama County Coordinated AB3030 Plan • Redding Basin AB3030 Plan
Sacramento	Glenn Colusa ID Reclamation District 108	• Glenn County Ordinance No. 1115 • Colusa County Ordinance No. 615 • Yolo County Export Ordinance No. 1617 • Glenn-Colusa ID AB3030 Plan • Reclamation District 108 AB3030 Plan
	Biggs-West Gridley WD Butte WD Richvale ID Western Canal WD	• Chapter 33 of the Butte County Code • Butte County Well Spacing Ordinance • Glenn County Ordinance No. 1115 and BMOs • Colusa County Ordinance No. 615 • Biggs-West Gridley WD AB3030 Plan • Richvale ID AB3030 Plan • Butte WD AB3030 Plan • Western Canal Water District AB3030 Plan
	Sutter Extension WD Garden Highway MWC	• Sutter Extension AB3030 Plan
	Yuba County Water Agency Members including: Brophy WD Browns Valley ID South Yuba WD Cordua WD Ramirez WD Dry Creek MWC Hallwood ID	• Yuba County transfer policies • Cordua ID AB3030 Plan • South Yuba AB3030 Plan • Browns Valley ID transfer policies
	Natomas Central MWC Sacramento Groundwater Authority	• Water Forum Agreement • Natomas Central MWC AB3030Plan • Sacramento County Water Agency Act, Sections 32-33 • SGA Regional Water Management Plan - currently being developed
North San Joaquin	Merced ID	• Merced ID AB3030 Plan • Merced Groundwater Basin AB3030 Plan • Merced County Wellhead Protection Program • Water Supply Plan and Update
South San Joaquin	See Table 6-17	See Table 6-17

Abbreviations: ID - Irrigation District, WD – Water District, AB3030 Plan– AB3030 Plan Groundwater Management Plan, RD – Reclamation District, BMOs – Basin Management Objectives, MWC – Mutual Water Company, YCWA – Yuba County Water Agency

Table 6-2
Components of Local Groundwater Management Plans

Water Agency/District AB3030 Plan	**Year Adopted**	**Saltwater Intrusion**	**Well head and recharge protection**	**Migration of contamination**	**Well abandonment and destruction**	**Overdraft mitigation**	**Groundwater replenishment**	**Monitoring**	**Conjunctive Use**	**Well construction policies**	**Construction and operation of facilities**	**Coordination with Other Agencies**	**Land use and groundwater contamination**
Anderson-Cottonwood ID	1998		X		X	X		X	X	X	X	X	X
Glenn-Colusa ID	1995				X		X	X	X	X	X	X	
Reclamation District 108	1997	X				X	X	X				X	
Biggs West Gridley WD	1995	X	X	X	X	X	X	X	X	X		X	
Butte WD	1996	X	X	X	X	X	X	X	X	X		X	X
Richvale ID	1995	X	X	X	X	X	X		X			X	
Sutter Extension WD	1995	X	X	X	X	X	X	X	X	X		X	
Western Canal WD	1995	X		X		X	X	X	X			X	
Yuba County WA[1]	2002	X	X	X	X	X	X	X	X		X	X	X
Cordua ID	1995	X	X	X	X	X	X	X	X	X		X	
South Yuba WD	1996	X	X	X	X	X	X	X	X	X		X	
Sacramento Ground Water Authority[2]	-			X		X	X	X	X		X	X	
Natomas Central MWC[3]	2002		2	1	2	1		1	1	2		1	
Merced Groundwater Basin	1997	X	X	X	X	X	X	X	X	X	X	X	X
Merced ID[1]	1996	X	X			X[4]	X		X			X	

[1] This is not a formal AB3030 Plan
[2] The Sacramento Groundwater Authority Regional Water Management Plan is being developed and may contain additional components not indicated in this table. This is not a formal AB3030 plan, yet many of the AB3030 Plan components are goals of the SGA and will be incorporated in the plan.
[3] The Natomas Central MWC Plan is not a formal AB3030 Plan. However, it contains many of the same elements stipulated in the Assembly Bill AB3030 Plan. These elements are prioritized as first and second priority as shown on the chart.
[4] Informally addressed in the Plan.

6.1.3 Upstream from the Delta Region

Potential groundwater acquisition areas Upstream from the Delta Region are in the Redding, Sacramento, and North San Joaquin Groundwater Basins. The following section provides information on the geology, hydrogeology, and hydrology; groundwater production, levels, and storage; land subsidence, and groundwater quality in these areas.

6.1.3.1 Redding Groundwater Basin

The Redding Groundwater Basin is in the northernmost part of the Sacramento Valley. Underlying Tehama and Shasta Counties, it is bordered by the Klamath Mountains to the north, the Coast Range to the west, and the Cascade Mountains to the east. Red Bluff Arch,[5] separates the Redding Groundwater Basin from the Sacramento Valley Groundwater Basin to the south. DWR Bulletin 118 subdivides the Redding Groundwater Basin into six subbasins: Anderson, Enterprise, Millville, Rosewood, Bowman, and South Battle Creek. Anderson-Cottonwood ID is the agency currently expected to transfer water to the EWA via groundwater substitution. Figure 6-2 shows the Redding Groundwater Basin and the Anderson-Cottonwood ID.

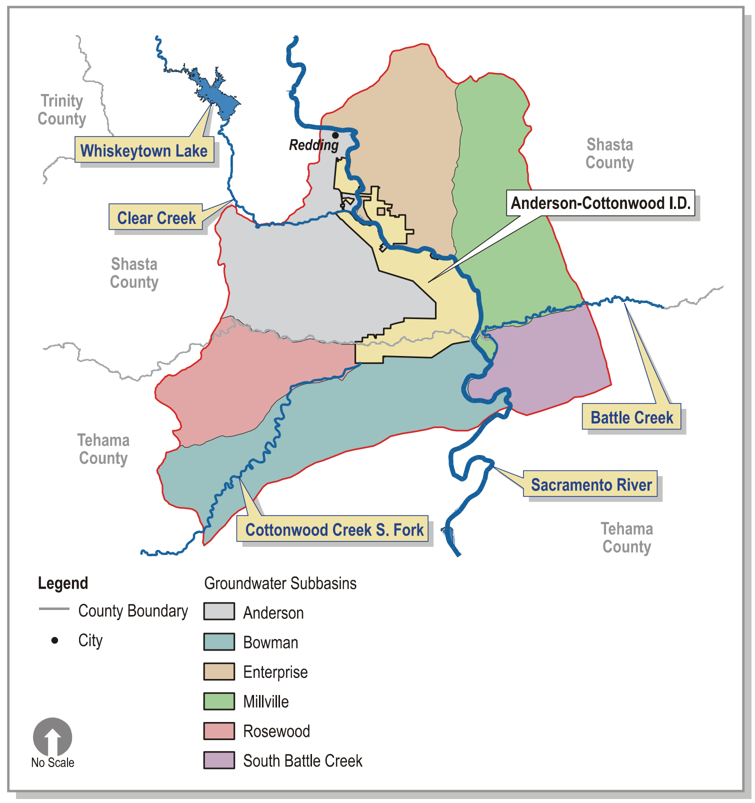


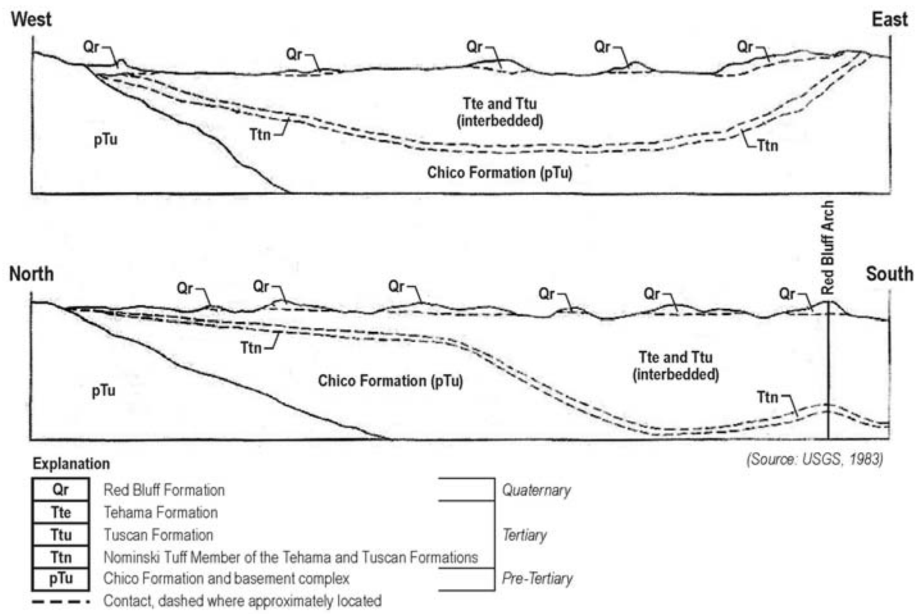
Figure 6-2
Redding Groundwater Basin

6.1.3.1.1 Geology, Hydrogeology and Hydrology

The Redding Groundwater Basin consists of a sediment-filled, southward plunging symmetrical trough (DWR 2001). Simultaneous deposition of material from the Coast Range and the Cascade Range resulted in two different formations, which are the principal freshwater-bearing formations in the basin. The Tuscan Formation in the east is derived from the Cascade Range volcanic sediments, and the Tehama Formation in the western and northwest portion of the basin is derived from Coast Range sediments. These formations are up to 2,000 feet thick near the confluence of

5 The Red Bluff Arch is a series of east-west trending folds of valley sediments, between the cities of Red Bluff and Redding. These folds divide the Sacramento Valley hydrogeologically into the Redding and Sacramento groundwater basins.

the Sacramento River and Cottonwood Creek, and the Tuscan Formation is generally more permeable and productive than the Tehama Formation (DWR 2001). Figure 6-3 shows generalized geologic cross sections across the Redding Basin (USGS 1983).



Source: USGS 1983

Figure 6-3
Geologic Cross Sections of the Redding Groundwater Basin

A large portion of recharge to the Redding Groundwater Basin is from precipitation and snowmelt from higher elevations. Average annual precipitation in the Redding Groundwater Basin ranges from 22 to as much as 40 inches in the higher elevations (California Spatial Library/DWR Statewide isohyet map). As is typical throughout the Central Valley, 80 to 90 percent of the area's precipitation occurs in November to April. In the surrounding mountain ranges, precipitation ranges from 40 to 75 inches, much of it in the form of snow.

The principal surface water features in the Redding Groundwater Basin are the Sacramento River and its tributaries: Battle Creek, Cow Creek, Little Cow Creek, Clear Creek, Dry Creek, and Cottonwood Creek. Surface water and groundwater interact in many areas in the Redding Basin. In general, groundwater flows southeasterly on the west side of the basin and southwesterly on the east side, toward the Sacramento River. The Sacramento River is the main drain for the basin (DWR Northern District 2002). In the northern portion of Anderson-Cottonwood ID, groundwater generally flows south-southeast toward the Sacramento River. In the southern portion of Anderson-Cottonwood ID, groundwater moves eastward along Cottonwood Creek and towards its confluence with the Sacramento River (DWR Northern District 2002). The Shasta County Water Resources Master Plan Phase 1 Report estimated the total annual groundwater discharge to rivers and streams at about 266,000 acre-foot, and seepage from streams and canals into groundwater at 59,000 and 44,000 acre-feet, respectively (Shasta County Water Agency, et al. 1997). Groundwater is typically unconfined to semi-confined in the shallow aquifer system and confined where deeper aquifers are present.

6.1.3.1.2 Groundwater Production, Levels, and Storage

Total annual groundwater pumping for the basin is approximately 37,000 acre-feet (DWR 1997), a minor amount compared to the basin's groundwater discharge to surface water of 266,000 acre-feet.

Groundwater levels typically vary annually from greater than 460 feet above mean sea level (msl) around the fringes of the basin, to less than 390 feet msl near the confluence of Cottonwood Creek and the Sacramento River. Historically, groundwater levels have remained relatively stable, with no long-term trend of declining or increasing levels. Some relatively short-term declines were noticeable during the droughts of 1976-1977 and in 1986-1994. These declines were followed by recovery to pre-drought levels.

DWR has estimated the total quantity of groundwater in storage in the Redding Groundwater Basin at approximately 6.9 MAF. This assumes a specific yield of 8.5 percent, an aquifer area of 33,300 acres, and a maximum saturated thickness of 2,470 feet (DWR 2002).

6.1.3.1.3 Land Subsidence

Land subsidence is the lowering of the land surface due to changes that take place underground. There are a number of potential causes of land subsidence including groundwater, oil, and gas extraction; dissolution of limestone aquifers; collapse of underground mines; drainage of organic soils; and initial wetting of dry soils (also called hydro-compaction). This EIS/EIR assesses land subsidence caused by groundwater pumping. Excessive groundwater extraction from confined and unconfined aquifers could result in a lowering of groundwater levels and, in confined aquifers, a decline in water pressure. Reduction in water pressure results in increased loading of the clay and silt beds, which may subsequently consolidate, resulting in lowering of the ground surface. The compaction of the fine-grained deposits is permanent.

Subsidence could cause damage to structures and increase flooding potential of low-lying land. Reduction in the permeability resulting from compaction of clay beds would slightly reduce the vertical movement of water in the aquifer system. Subsidence is most likely under the following conditions: 1) highly confined aquifer system, 2) coarse-grained aquifers that have thin clay layers interspersed throughout the strata, 3) clay interbeds that are subjected to a low degree of natural pre-consolidation pressures, and 4) large reduction in groundwater levels (DWR Northern District 2002).

Land subsidence has never been monitored in the Redding Groundwater Basin. However, there would be potential for subsidence in some areas of the basin if groundwater levels were substantially lowered. The groundwater basin west of the Sacramento River is composed of the Tehama Formation, which has exhibited subsidence in Yolo County (Dudley 2002).

6.1.3.1.4 Groundwater Quality

Groundwater in the Redding area of analysis is typically of good quality, as evidenced by its low total dissolved solids (TDS) concentrations, which range from 70 to 360 mg/L.[6] Areas of high salinity, or poor water quality, are generally on the basin margins, where the groundwater is derived from marine sedimentary rock. Elevated levels of iron, manganese, nitrate, and high TDS have been detected in some areas. High levels of boron have been detected in the southern portion of the basin (DWR 2002 and DWR Northern District 2002).

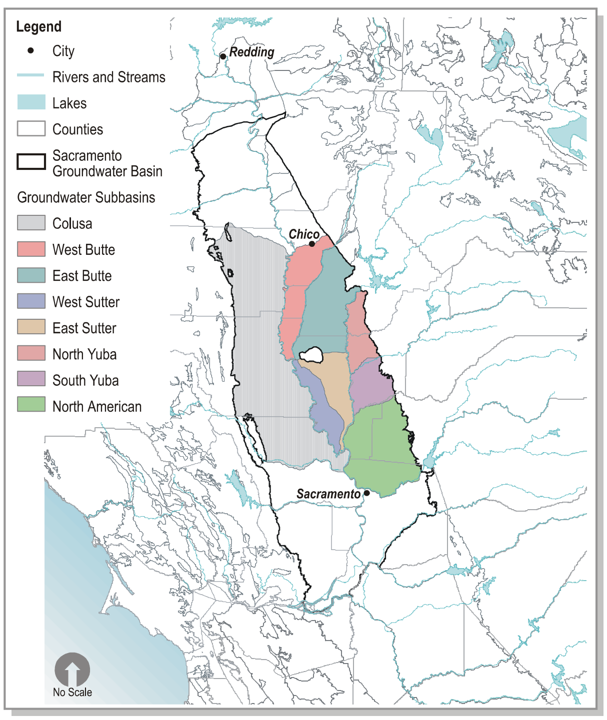


Figure 6-4
Sacramento Groundwater Basin

6.1.3.2 Sacramento Groundwater Basin

The Sacramento Groundwater Basin extends from the Redding Groundwater Basin to the San Joaquin Valley including Tehama, Glenn, Butte, Yuba, Colusa, Placer and Yolo Counties. It is bordered by Red Bluff Arch to the north, the Coast Range to the west, the Sierra Nevada to the east, and the San Joaquin Valley to the south. Bulletin 118 further divides the Sacramento Groundwater Basin into subbasins. Figure 6-4 shows the Sacramento Groundwater Basin and subbasins within the area of analysis. The agencies expected to transfer assets to the EWA Project Agencies via groundwater substitution or groundwater purchase are described in Section 6.2.4, Environmental Consequences and Impacts of the Flexible Purchase Alternative.

6.1.3.2.1 Geology, Hydrogeology, and Hydrology

The Sacramento Groundwater Basin is a north-northwestern trending asymmetrical trough filled with as much as 10 miles of both marine and continental rocks and sediment (Page 1986). On the eastern side, the basin overlies basement bedrock that rises relatively gently to form the Sierra Nevada, while on the western side the underlying basement bedrock rises more steeply to form the Coast Ranges. Overlying the basement bedrock are marine sandstone, shale, and conglomerate rocks, which generally contain

[6] TDS concentrations above 500 mg/L may cause adverse effects to some crops.

brackish or saline water (DWR 2001). The more recent continental deposits, overlying the marine sediments, contain freshwater. These continental deposits are generally 2,000 to 3,000 feet thick (Page 1986). The depth (below ground surface) to the base of freshwater typically ranges from 1,000 to 3,000 feet (Bertoldi 1991). Along the eastern and northeastern portion of the basin are the Tuscan and Mehrten formations, derived from the Cascade and Sierra Nevada. The Tehama Formation in the western portion of the basin is derived from Coast Range sediment. In most of the Sacramento Groundwater Basin, the Tuscan, Mehrten, and Tehama formations are overlain with relatively thin alluvial deposits.

In the Sacramento Groundwater Basin, freshwater is present primarily in the Tuscan, Mehrten, and Tehama formations and in alluvial deposits. Figures 6-5 and 6-6 are generalized cross sections for the northern and southern portions of the Sacramento Groundwater Basin, respectively. Groundwater users in the basin pump primarily from deeper continental deposits.

Groundwater is recharged by deep percolation of applied water and rainfall infiltration from streambeds and lateral inflow along the basin boundaries. Average annual precipitation in the Sacramento Groundwater Basin ranges from 13 to 26 inches, with the higher precipitation occurring along the eastern and northern edges of the basin. Typically, 80 to 90 percent of the basin's precipitation occurs from November to April. Further east in the Sierra Nevada, precipitation ranges from 40 to 90 inches, much in the form of snow (Bertoldi 1991). The quantity and timing of snowpack melt are the predominant factors affecting the surface and groundwater hydrology, and peak runoff in the basin typically lags peak precipitation by one to two months (Bertoldi 1991). The main surface water feature in the Sacramento Groundwater Basin is the Sacramento River, which has several major tributaries draining the Sierra Nevada, including the Feather River, Yuba River, and American River. Stony Creek, Cache Creek, and Putah Creek, draining the Coast Range are the main west side tributaries of the Sacramento River. Surface water and groundwater interact on a regional basis, and, as such, gains and losses to groundwater vary significantly geographically and temporally. In areas where groundwater levels have declined, such as in Sacramento County, streams that formerly gained water from groundwater now lose water to the groundwater system through seepage.

6.1.3.2.2 Groundwater Production, Levels and Storage

Irrigated agriculture in the Sacramento Groundwater Basin increased steadily from less than 500,000 acres in the 1940s to more than 1.5 million acres by 1980 (Reclamation 1997). Correspondingly, groundwater production to support the agriculture rose from less than 500,000 acre-feet annually to more than 2 million acre-feet annually by the mid-1990s (DWR 1998).

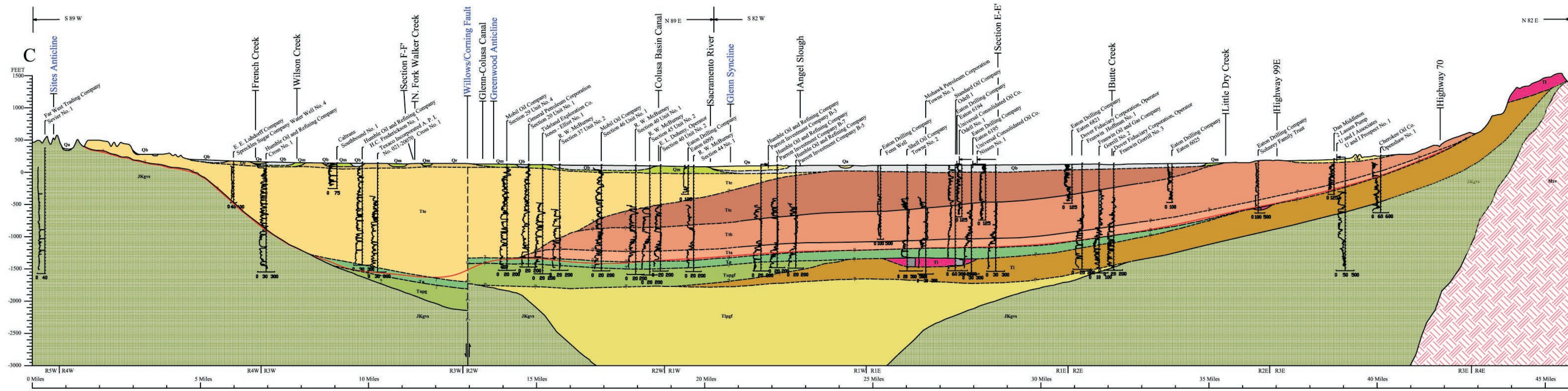
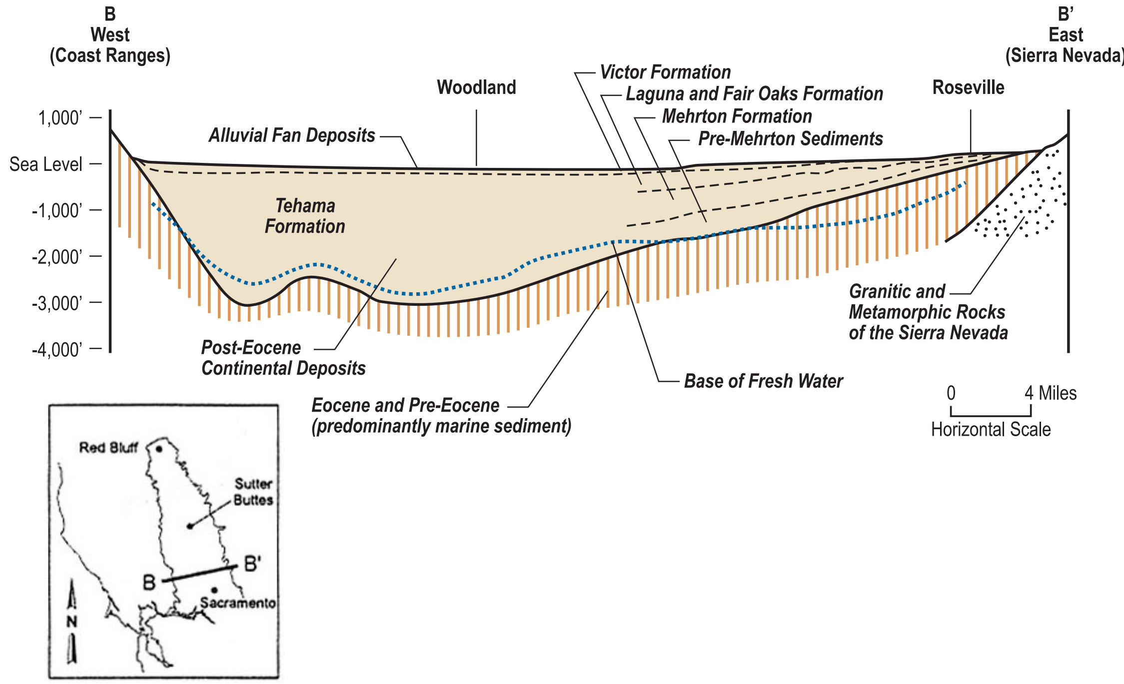


Figure 6-5
North Geologic Cross Section of the Sacramento Groundwater Basin (Chico to Black Butte)
Provided by: DWR North District



Source: DWR North District 2002

Figure 6-6
South Geologic Cross Section of the Sacramento Groundwater Basin

Figure 6-7 shows the spring 1997-groundwater elevation contours and Figure 6-8 shows the 1997 depth to groundwater contours. In general, groundwater flows inward from the edges of the basin and south parallel to the Sacramento River. In some areas there are groundwater depressions associated with extraction that influence local groundwater gradients. Prior to the completion of CVP facilities in the area (1964-1971), pumping along the west side of the basin caused groundwater levels to decline. Following construction of the CVP, the delivery of surface water and reduction in groundwater extraction resulted in a recovery to historic groundwater levels by the mid to late-1970s. Throughout the basin, individuals, counties, cities, and special legislative agencies manage and/or develop groundwater resources. Many agencies use groundwater to supplement surface water; therefore, groundwater production is closely linked to surface water availability.

6.1.3.2.3 Land Subsidence

Historically, land subsidence occurred in the eastern portion of Yolo County and the southern portion of Colusa County, owing to groundwater extraction and geology. Figure 6-9 shows the extent of documented historical subsidence and areas of possible subsidence based on anecdotal evidence and past studies. The earliest studies on land subsidence in the Sacramento Valley occurred in the early 1970s when the USGS, in cooperation with DWR, measured elevation changes along survey lines containing first and second order benchmarks. Results indicated subsidence between 1934 and

1942, in 1964, and in 1967 between Zamora and Davis and between Zamora and Arbuckle. A 1994 USGS study using a global positioning system survey indicated a subsidence rate of 4 cm/yr for areas centered on Davis and extending toward Dixon and an area centered on Woodland extending toward Zamora (DWR Northern District 2002). Figure 6-10 presents profiles of land subsidence between Madison and Davis**.** These profiles were determined from leveling-control lines and indicated a substantial amount of subsidence between 1935 and 1987 in the Davis-Woodland area (Lofgren 1987)**.**

DWR is monitoring land subsidence in several areas throughout the Sacramento Valley. Figure 6-9 shows the location of the extensometers[7] and the data from the Zamora and Conaway Ranch extensometers. These figures indicate that the ground surface displacement generally occurs during periods of high groundwater extraction. The Conaway Ranch extensometer shows a net reduction (inelastic subsidence) of less than half an inch between 1991 and 2001 while the Zamora Extensometer shows a net reduction of about 2 inches over the same time period. Additional data from the Zamora extensometer, not shown here, indicates a net subsidence of over 6 inches from 1988 to 1992. Yolo County, in cooperation with DWR, has developed a countywide global positioning system (GPS) designed to survey and monitor future land subsidence (DWR Northern District 2002).

6.1.3.2.4 Groundwater Quality

Groundwater quality in the Sacramento Groundwater Basin is generally good and sufficient for municipal, agricultural, domestic, and industrial uses. However, there are some localized groundwater quality issues in the basin. In general, natural groundwater quality is influenced by stream flow and recharge from the surrounding Coast Ranges and Sierra Nevada. Runoff from the Sierra Nevada is generally of higher quality than runoff from the Coast Ranges, because of the presence of marine sediments in the Coast Range. Specific groundwater quality issues are discussed below.

7 Instruments used to measure movements of soil and rock.

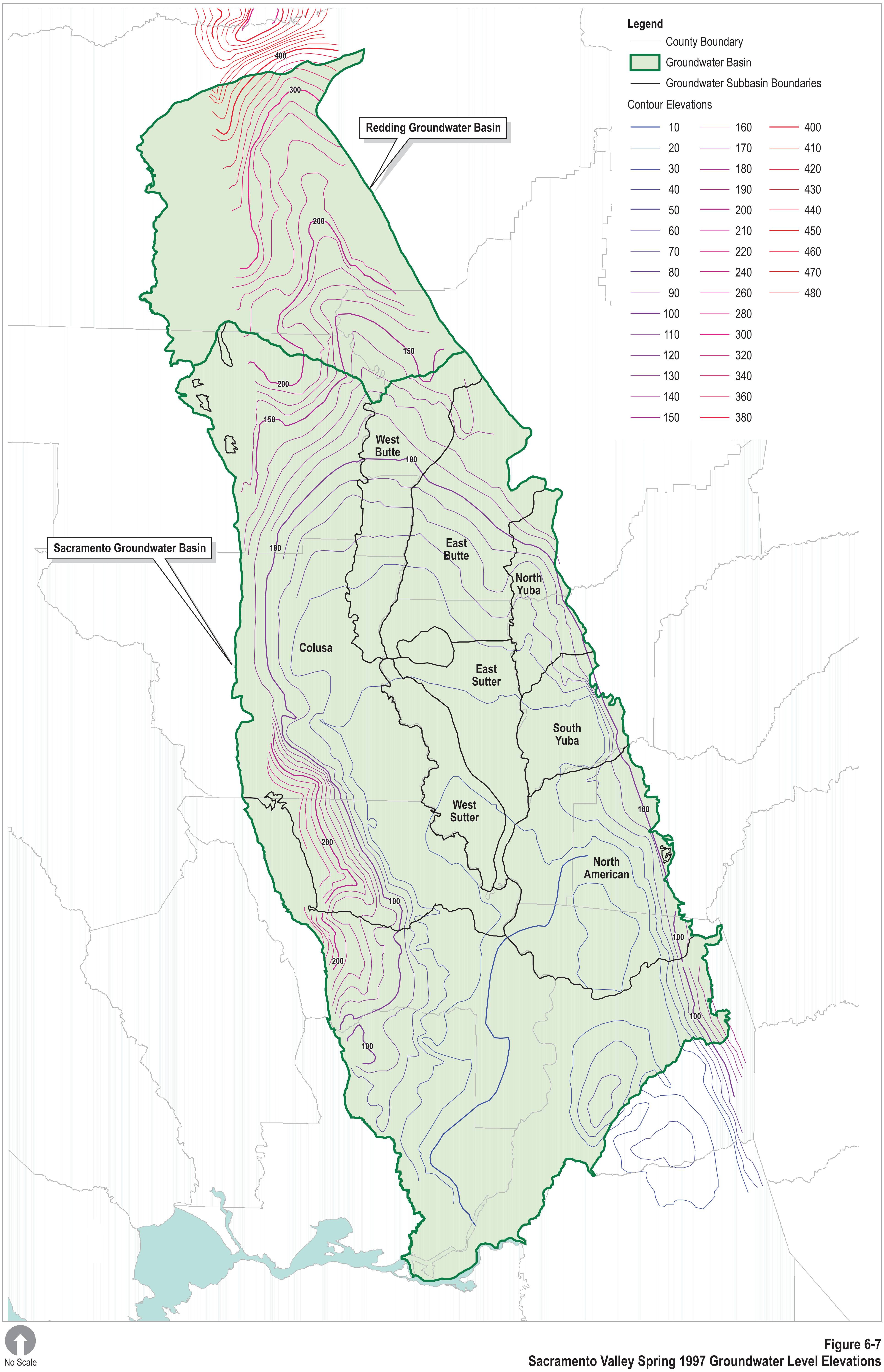


Figure 6-7
Sacramento Valley Spring 1997 Groundwater Level Elevations
Contours Provided by: DWR North District

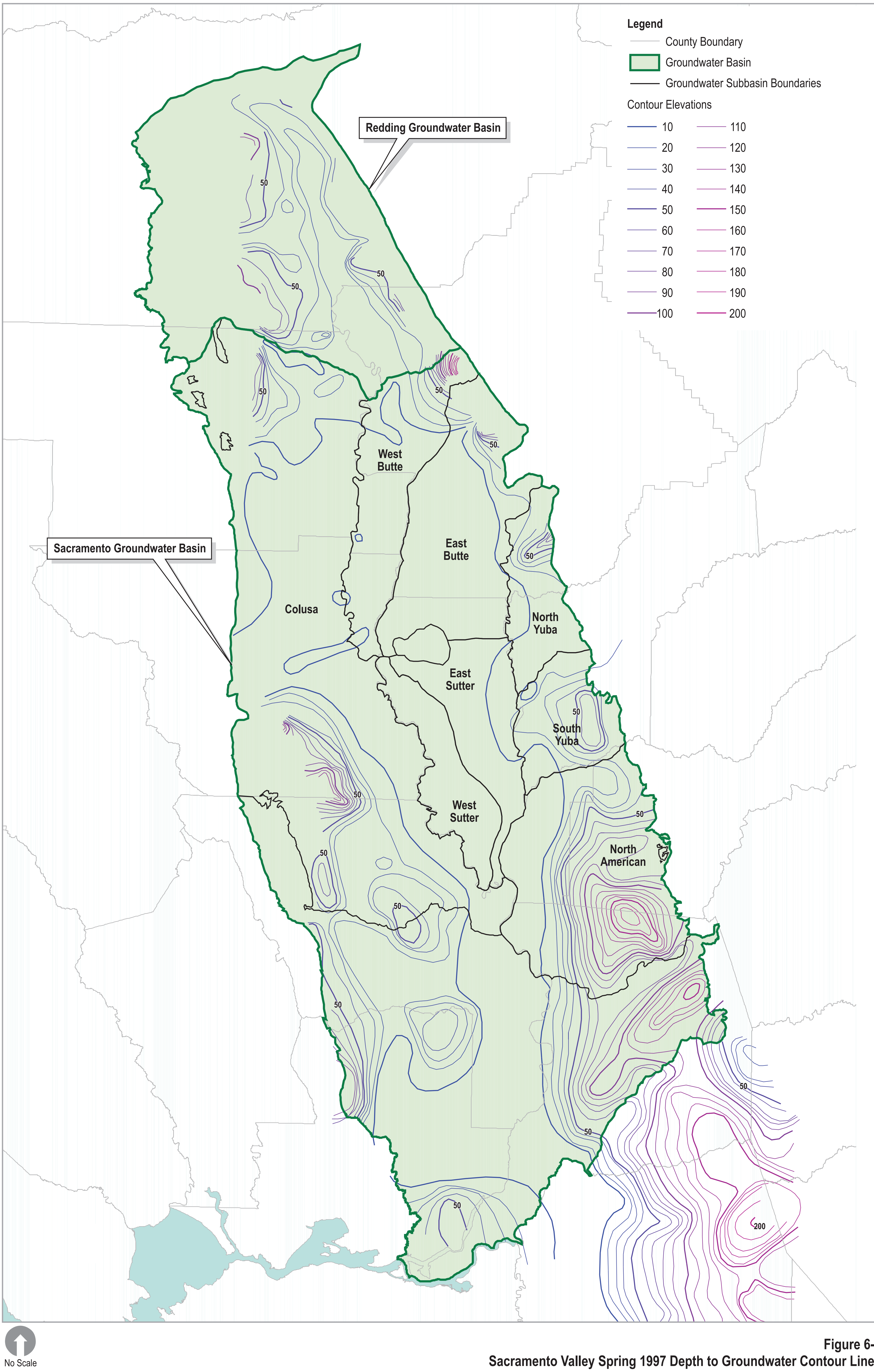


Figure 6-8
Sacramento Valley Spring 1997 Depth to Groundwater Contour Lines
Contours Provided by: DWR North and Central Districts

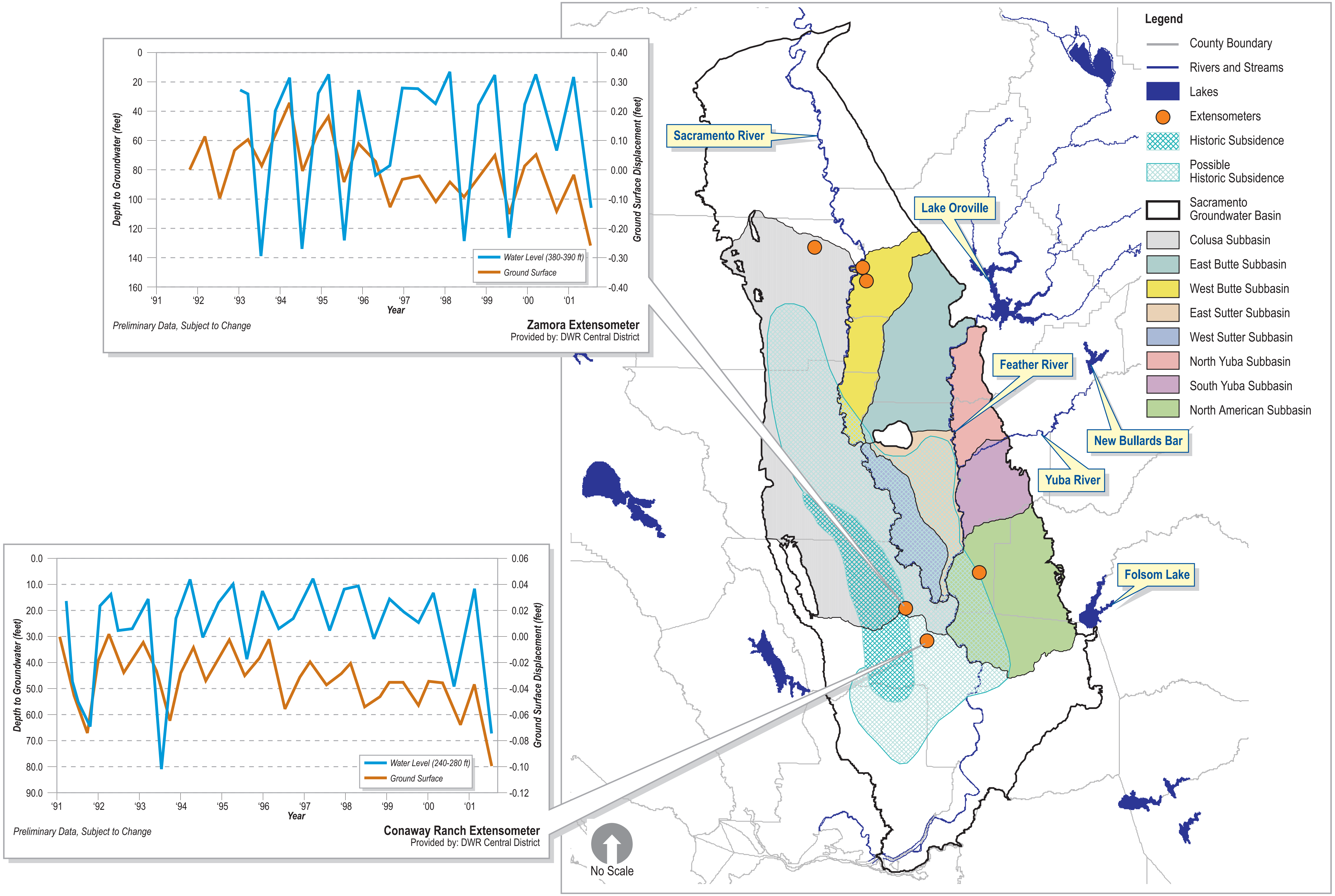
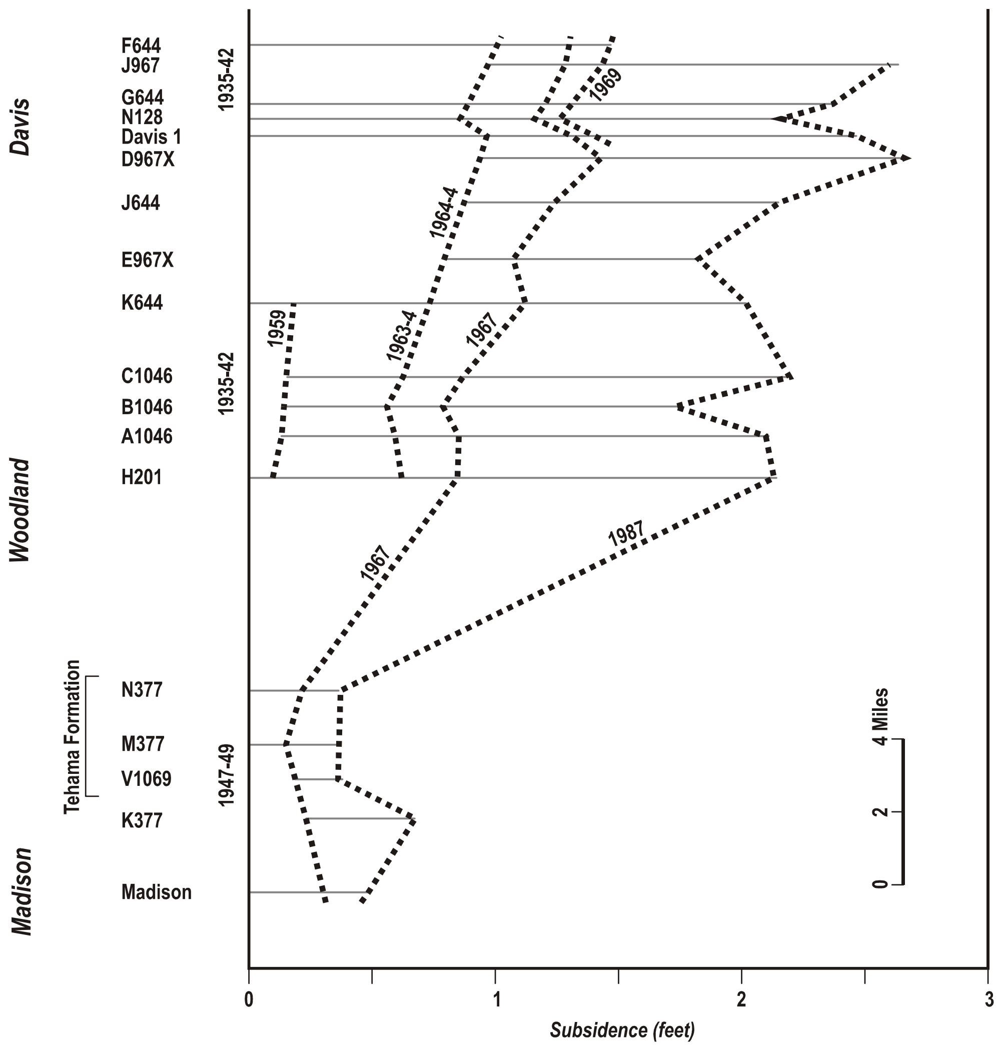


Figure 6-9
Land Subsidence in the Sacramento Groundwater Basin
Provided by: DWR Water Transfers Office



Source: Lutgren 1987

Figure 6-10
Profile of Land Subsidence in Eastern Yolo County

TDS generally consist of inorganic salts and small amounts of organic matter. The California and EPA secondary drinking water standard for TDS is 500 milligrams per liter (mg/L), and the agricultural water quality goal for TDS is 450 mg/L. Generally, in the Sacramento Basin, TDS levels are between 200 and 500 mg/L, while in the southern part of the basin the TDS levels are higher than that due to the local geology. Along the eastern boundary of the basin, TDS concentrations tend to be less than 200 mg/L, indicative of the low level of TDS concentrations in Sierra Nevada runoff. Several areas in the basin have naturally occurring high concentrations of TDS, with concentrations that exceed 500 mg/L. TDS concentrations as high as 1,500 mg/L have been recorded (Bertoldi 1991). One of these high TDS areas is west of the Sacramento

River, between Putah Creek and the confluence of the Sacramento and San Joaquin Rivers; another is in the south-central part of the Sacramento Basin, south of Sutter Buttes, in the area between the confluence of the Sacramento and Yuba Rivers.

Nitrate (measured as nitrogen) is regulated in drinking water and has an MCL of 10 mg/L. Nitrates found in groundwater could be due to fertilizer use, leachate from septic tanks, wastewater disposal, and natural deposits. In irrigation water, nitrate could be an asset because of its value as a fertilizer; however, algae growth and environmental problems could arise from concentrations exceeding 30 mg/L. Concentrations of nitrate as nitrogen exceeding 10 mg/L are found throughout the Central Valley; however, concentrations exceeding 30 mg/L are rare and localized (Bertoldi 1991). In the Sacramento Groundwater Basin, two areas of potential nitrate problems have been identified: one in northern Yuba and southern Butte Counties, east of Sutter Buttes, and another in northern Butte and southern Tehama Counties (Reclamation 1997).

In low concentrations, boron is important for plant growth, but it could adversely affect certain crops at concentrations as low as 0.5 mg/L. In the Central Valley, boron is usually from natural sources, such as marine deposits; in general, only localized portions of the Sacramento Basin have concentrations exceeding 0.75 mg/L, the largest area being in the southwestern part of the basin from Arbuckle to Rio Vista (Bertoldi 1991).

Arsenic and selenium are naturally occurring trace elements. The California drinking water standard for selenium is 0.05 mg/L. On January 22, 2001, EPA lowered the arsenic standard from 0.05 mg/L to 0.01 mg/L. All systems must comply by January 23, 2002 (Groundwater Resources Association of California 2003). For agricultural use, arsenic concentrations should not exceed 1 mg/L. Selenium is toxic to humans and animals at low concentrations and can accumulate in the environment and in wildlife (DWR Northern District 2002). According to the SWRCB, there are no elevated concentrations of arsenic or selenium in the Sacramento Groundwater Basin.

6.1.3.3 North San Joaquin Groundwater Basin

The San Joaquin Valley Basin extends over the southern two-thirds of the Central Valley regional aquifer system and has an area of approximately 13,500 square miles. The North San Joaquin Groundwater Basin, shown on Figure 6-11, is the northern half of the San Joaquin Valley Basin, extending from just south of Stockton in San Joaquin County to north of Fresno in Fresno County, covering approximately 5,800 miles. Merced ID (Figure 6-11) is in the Merced groundwater subbasin, situated between the Chowchilla River to the south and the Merced River to the north. Merced ID is expected to transfer water to the EWA Project Agencies via groundwater purchase.

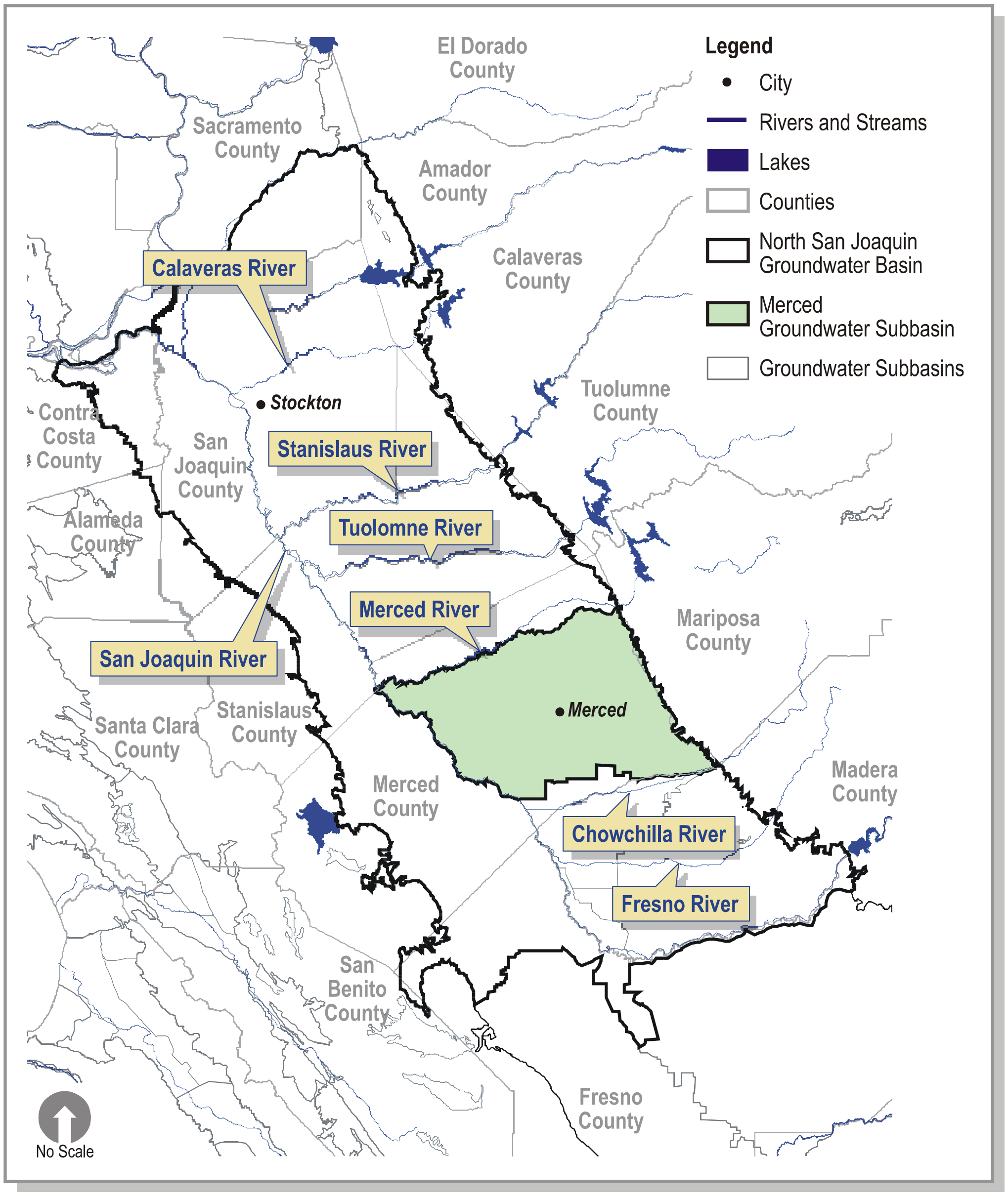
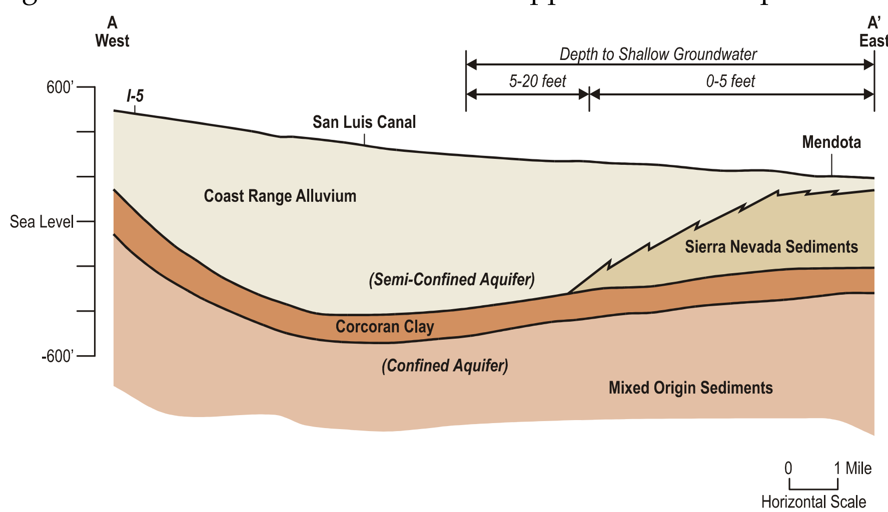


Figure 6-11
North San Joaquin Groundwater Basin

6.1.3.3.1 Geology, Hydrogeology, and Hydrology

The North San Joaquin Groundwater Basin is geometrically similar to the Sacramento Groundwater Basin and was formed by the deposition of several miles of sediment in a north-northwestern trending trough. On the eastern side of the basin is the Sierra Nevada, and on the western side is the Coast Ranges.

The aquifer system in the North San Joaquin Groundwater Basin comprises up to 6 miles of continental and marine deposits, of which the upper 2,000 feet generally contain freshwater (Page 1986). A significant hydrogeologic feature in the basin is the Corcoran Clay. This clay layer divides the aquifer system into two distinct aquifers, an unconfined to semi-confined upper aquifer and a confined aquifer below.[8] Both aquifer systems are composed of formations derived from the deposition of Sierra Nevada sediment in the eastern portions of the basin, and from deposition of Coast Range sediments in western portions of the basin. Overlying these formations are flood plain deposits. The formations in the eastern portions of the basin are derived from the granitic Sierra Nevada and are generally more permeable than the sediments derived from western marine formations. Sediments derived from marine rocks generally contain more silt and clay and also contain higher concentrations of salts. The lower confined aquifer system contains sediments of mixed origin. Historically, these aquifers were two separate systems; however, deep wells have penetrated both aquifers, resulting in groundwater interaction between the upper and lower aquifer in some localized areas (Reclamation 1990). Figure 6-12 shows a generalized geologic cross section of the North San Joaquin Groundwater Basin.



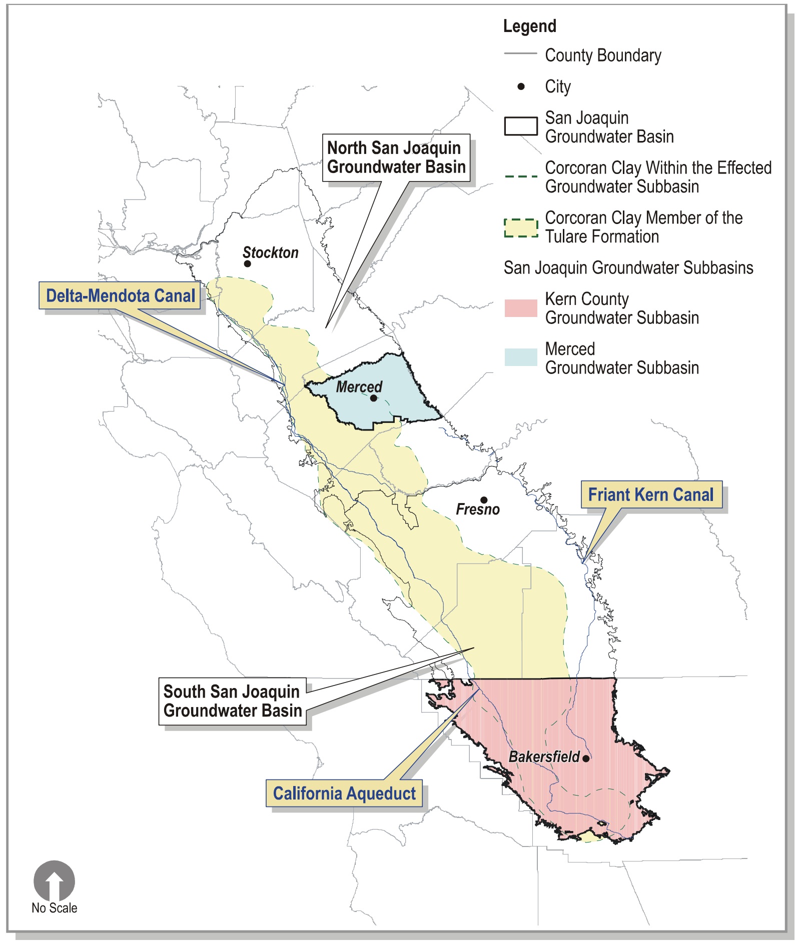
Source: Reclamation 1997

Figure 6-12
Geologic Cross Section of the North San Joaquin Groundwater Basin

---

8 Confined aquifers lie between two aquitards (strata within a geologic sequence that are of low permeability, impeding groundwater flow).

The Corcoran Clay, the most extensive of several clay layers, is formed by the periodic filling and draining of ancient lakes in the San Joaquin Valley. Six laterally extensive clays, designated clays A through F, have been mapped (Page 1986). The Modified E clay includes the Corcoran Clay, which is between 0 and 160 feet thick at depths between 100 and 400 feet below ground surface. Figure 6-13 shows the lateral extent of the Corcoran Clay layer.



Source: CALFED 2000

Figure 6-13
Corcoran Clay Member in the San Joaquin Valley

Historically, groundwater in the unconfined to semi-confined upper aquifer system was recharged by streambed infiltration, rainfall infiltration, and lateral inflow along the basin boundaries. Average annual precipitation in the area is significantly less than in the Sacramento Groundwater Basin and ranges from 6 to 18 inches, although the majority of the basin receives between 9 and 13 inches (California Spatial Library/DWR statewide isohyet map). The percolation of applied agricultural surface water has supplemented natural groundwater replenishment. The lower confined aquifer is recharged primarily from lateral inflow from the eastern portions of the basin, beyond the eastern extent of the Corcoran Clay Member. Precipitation in the Sierra Nevada to the east of the basin can be as high as 65 to 75 inches, although much of it is in the form of snow. Peak runoff in the basin generally lags precipitation by 5 to 6 months (Bertoldi 1991).

The main surface water feature in the North San Joaquin Groundwater Basin is the San Joaquin River, which has several major tributaries draining the Sierra Nevada, including the Fresno, Chowchilla, Merced, Tuolumne, and Stanislaus Rivers. Historically, these streams were "gaining" streams (they had a net gain of water from groundwater discharge). With the decline of groundwater levels in the basin, areas of substantial pumping have reversed the local groundwater flow, and reaches of streams now lose water to the aquifer system.

6.1.3.3.2 Groundwater Production, Levels, and Storage

Irrigated agriculture in the North San Joaquin Groundwater Basin rose from about 1 million acres in the 1920s to more than 2.2 million acres by the early 1980s (Reclamation 1997). Groundwater production to support agriculture rose from approximately 1.5 MAF per year in the 1920's to more than 3.5 MAF per year for 1990 (Reclamation 1997).

Prior to the large-scale development of irrigated agriculture, groundwater in the basin generally flowed from the edges of the basin toward the San Joaquin River and ultimately to the Delta. Extensive groundwater pumping and irrigation (with imported surface water) have modified local groundwater flow patterns and in some areas, groundwater depressions are evident. Figure 6-14 shows springtime groundwater elevations, and Figure 6-15 shows the average depth to groundwater for both the North and South San Joaquin Valley Groundwater basins.

6.1.3.3.3 Land Subsidence

From the 1920s until the mid-1960s, the use of groundwater for irrigation of crops in the San Joaquin Valley increased rapidly, causing land subsidence throughout the west and southern portions of the valley. From 1920 to 1970, almost 5,200 square miles of irrigated land in the San Joaquin River Watershed registered at least one foot and as much as 30 feet of land subsidence in northwest Fresno County. Land subsidence is concentrated in areas underlain by the Corcoran Clay Member. Figure 6-16 shows areas of subsidence in the San Joaquin Valley from 1926 to 1970. Substantial land subsidence was observed in the Los Banos-Kettleman City area, the Tulare-Wasco area, and the Arvin-Maricopa area during this period (CALFED 2000).

Land subsidence studies conducted during the 1950s and 1970s focused on the vicinity of the California Aqueduct. During this period, the State was considering construction of the California Aqueduct, and subsidence due to the large amount of groundwater extraction in the area was a major concern. Following construction, delivery of surface water conveyed by the aqueduct reduced the irrigators' need to extract groundwater, thus reducing the rate of subsidence. Relatively little data have been gathered in the area since the 1970s (Steele 2002).

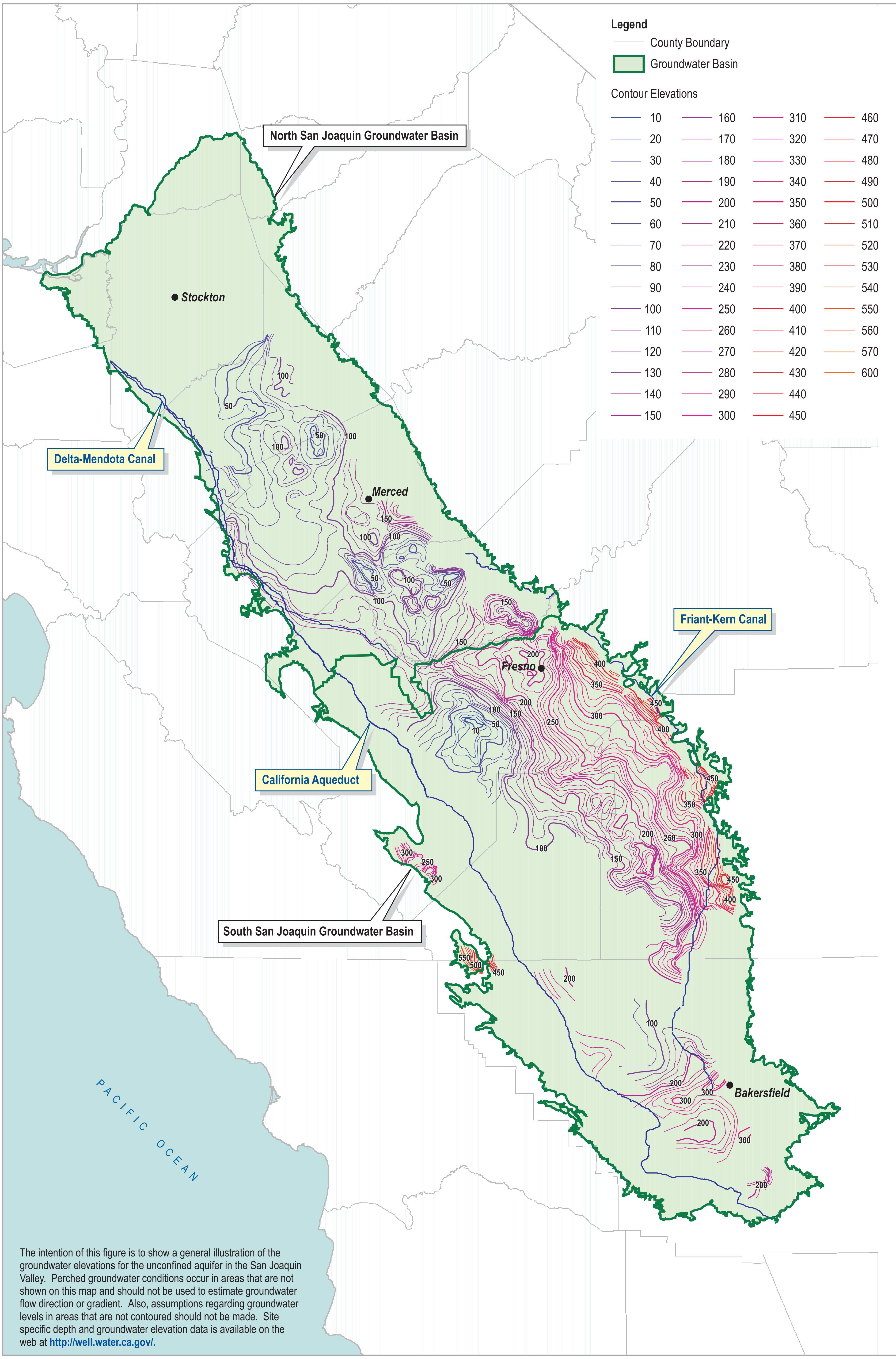
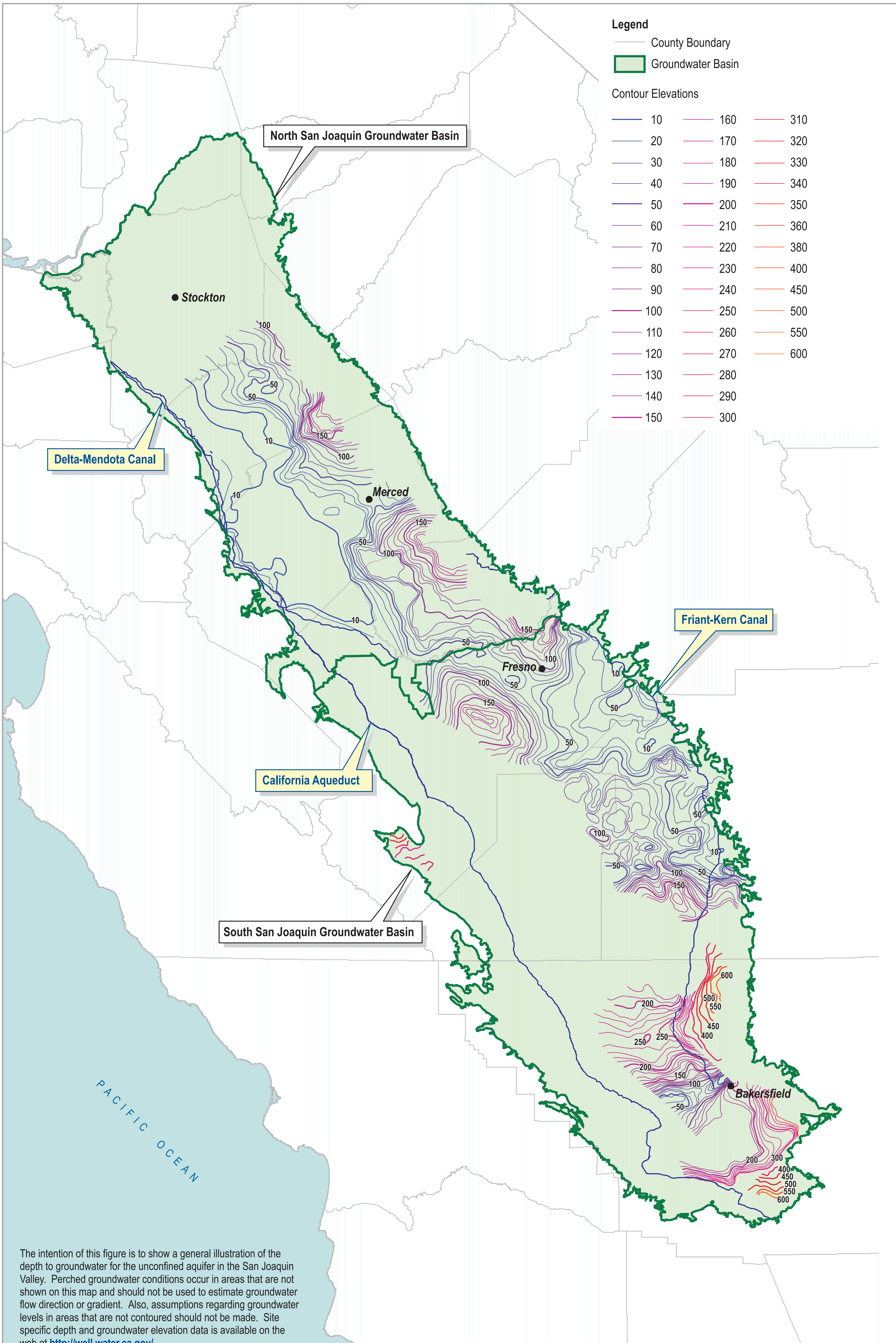
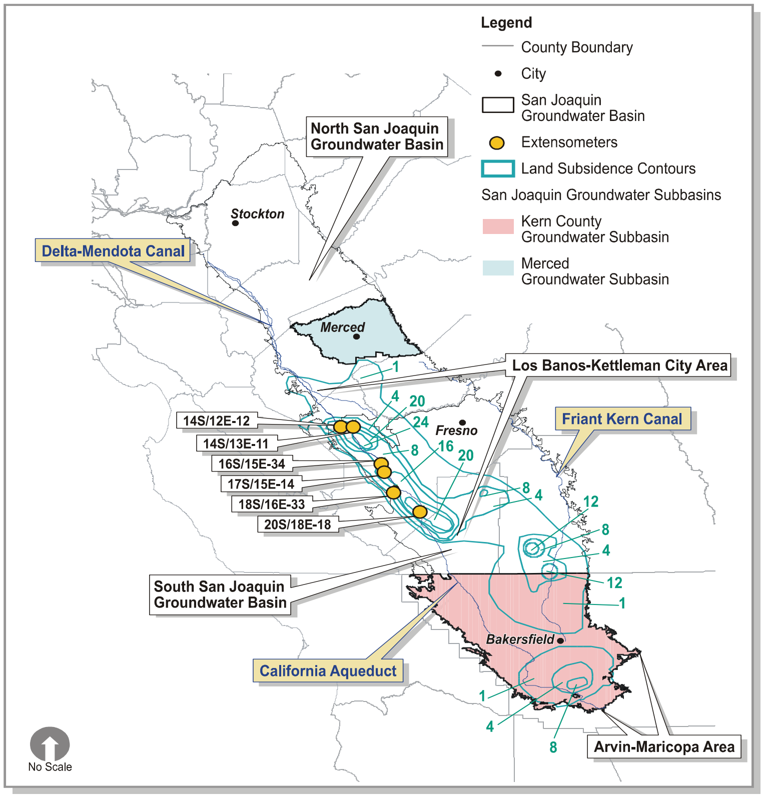


Figure 6-14
San Joaquin Spring 2000 Groundwater Level Elevations in the Unconfined Aquifer
Contours Provided by: DWR San Joaquin District



The intention of this figure is to show a general illustration of the depth to groundwater for the unconfined aquifer in the San Joaquin Valley. Perched groundwater conditions occur in areas that are not shown on this map and should not be used to estimate groundwater flow direction or gradient. Also, assumptions regarding groundwater levels in areas that are not contoured should not be made. Site specific depth and groundwater elevation data is available on the web at **http://well.water.ca.gov/.**

Figure 6-15
San Joaquin Spring 2000 Depth to Groundwater in the Unconfined Aquifer
Contours Provided by: DWR San Joaquin District



Source: CALFED 2000

Figure 6-16
Historical Land Subsidence in the San Joaquin Valley (1926 to 1970)

Land subsidence measurements have shown that an increase in groundwater pumping during 1984 -1996 resulted in land subsidence of up to 2 feet along the Delta-Mendota Canal (CALFED 2000). Similarly, increased pumping caused Westlands WD to experience up to 2 feet of subsidence between 1983 – 2001, with most of the subsidence occurring after 1989 (Westlands WD 2000). DWR has 6 extensometers near to the California Aqueduct that also measure subsidence. Figure 6-16 shows the locations of these extensometers, and Figure 6-17 shows the extent of subsidence from 1983 to 1998. Land subsidence would continue to be a potentially adverse effect if overdraft of the underlying aquifers continues.

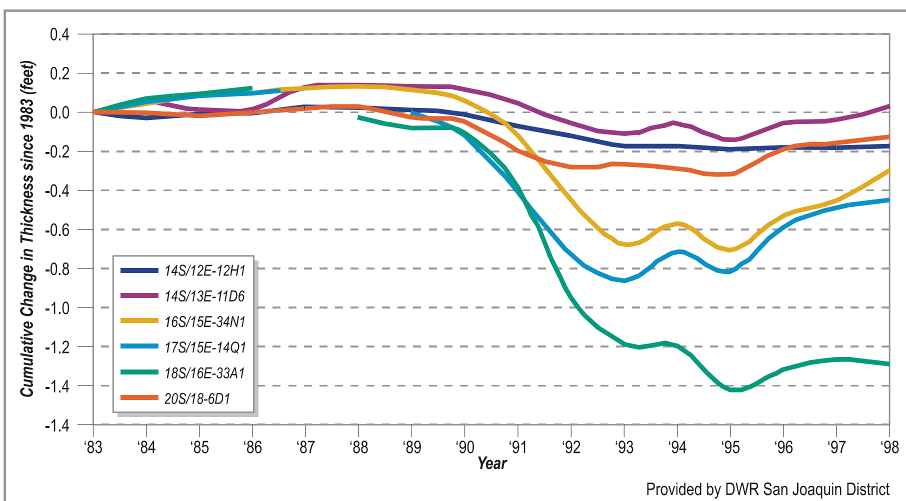


Figure 6-17
Extensometer Land Subsidence Monitoring in the San Joaquin Valley

6.1.3.3.4 *Groundwater Quality*

Groundwater quality varies throughout the North San Joaquin Groundwater Basin. TDS concentrations in the North San Joaquin Groundwater Basin are generally higher than in the Sacramento Basin, and concentrations along the east side of the Basin are generally lower than along the west side, because of the higher quality of aquifer recharge and soil types. TDS concentrations east of the San Joaquin River are generally less than 500 mg/L, whereas west of the river, concentrations are typically greater than 500 mg/L (Bertoldi 1991). The marine origin of the west-side formations is the primary reason for this difference. The accumulation of salts from imported surface irrigation water has also contributed to the problem, resulting in TDS concentrations in shallow drainage water exceeding 2,000 mg/L. Local agriculture is impaired[9] by high levels of boron, arsenic, selenium, and pesticides throughout the valley (CALFED 2000). High boron concentrations have been reported in the northwestern part of the basin, extending south toward the Kings-Fresno County line (Bertoldi 1991). Agricultural use of groundwater is impaired by elevated boron concentrations in eastern Stanislaus and Merced counties (SWRCB 1991).

6.1.4 Delta Region

No groundwater transfers related to the EWA Program are anticipated in the Delta Region; thus, groundwater resources would not be affected. Consequently, this chapter does not discuss the Delta Region.

6.1.5 Export Service Area/ South San Joaquin Groundwater Basin

Potential groundwater acquisition areas in the Export Service Area are in the South San Joaquin Groundwater Basin. The following section provides information on the geology, hydrogeology, and hydrology; groundwater production, levels, and storage; land subsidence, and groundwater quality in this area.

The South San Joaquin Groundwater Basin is in the southern half of the San Joaquin Valley, an area called the Tulare Lake Region. Covering approximately 8,000 square miles, the South San Joaquin Groundwater Basin (Figure 6-18) extends from the Fresno-Madera County line south through Kings and Tulare counties, and into Kern County. DWR Bulletin 118 divides the basin into six subbasins: Kings, Westside, Tule, Tulare, Kaweah, and Kern. A number of agencies participating in groundwater banks in Kern County may be potential EWA sellers to the EWA Program.

---

9 Poor groundwater quality inhibits the intended beneficial use of the water.

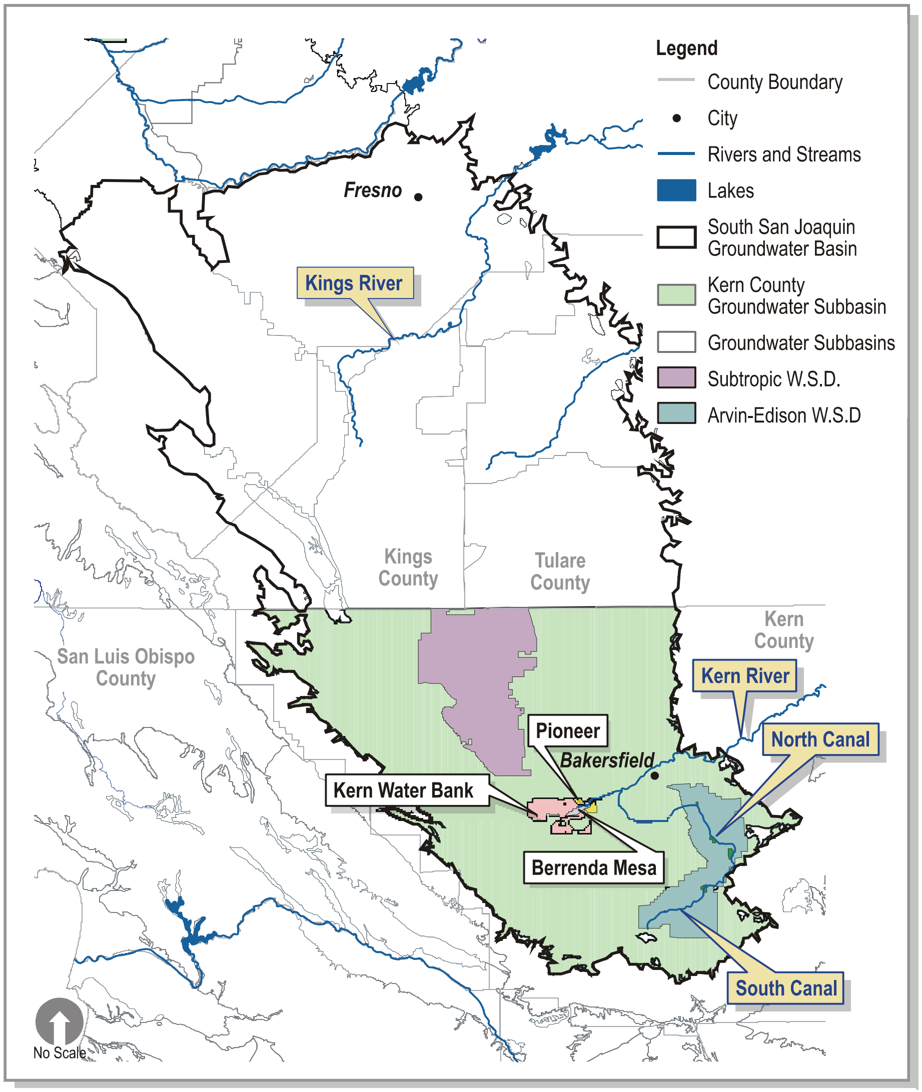


Figure 6-18
South San Joaquin Groundwater Basin

6.1.5.1 Geology, Hydrogeology, and Hydrology

The geology and hydrogeology of the South San Joaquin Groundwater Basin is similar to the North San Joaquin Basin; this section includes only additional relevant information.

In addition to the hydrogeologic features described for the North San Joaquin Groundwater Basin (Section 6.1.3.3), the South San Joaquin Basin contains the Tulare Lake sediments along the axis of the basin (Reclamation 1997). Figure 6-19 shows a generalized cross section of the basin. The Tulare Lake sediments are estimated to be more than 3,600 feet thick, with a lateral extent of more than 1,000 square miles (Page 1986). The Corcoran Clay layer, which is present almost to the west side of the San Joaquin Valley, is considered geologically to be part of the Tulare Formation. On the east and west sides of the basin semi-confined aquifer conditions exist; below the Corcoran Clay, confined aquifer conditions exist.

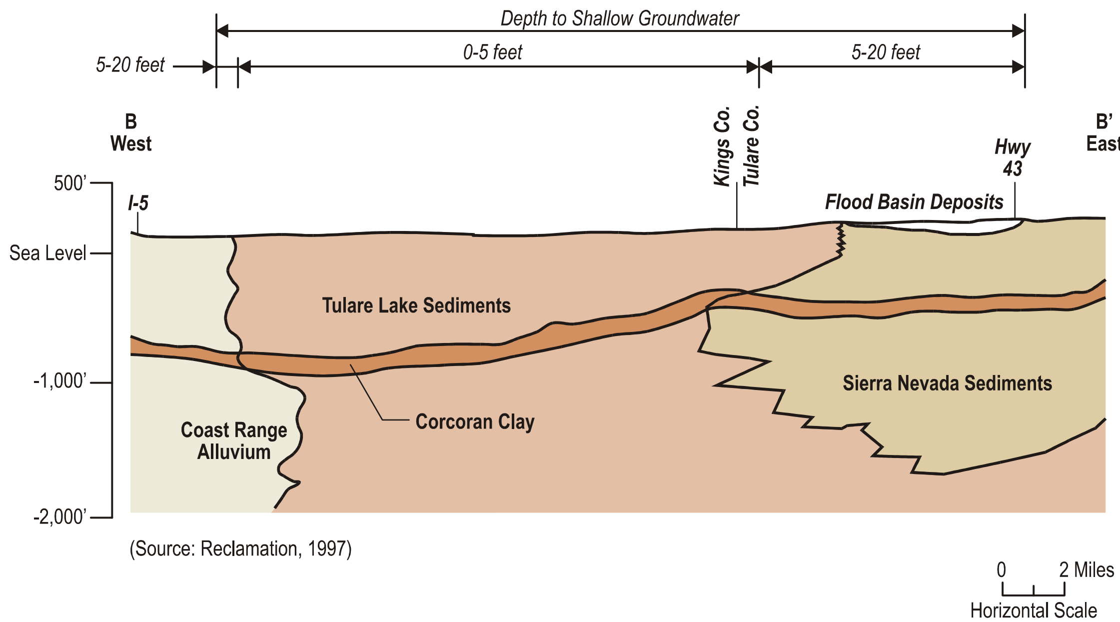


Figure 6-19
Geologic Cross Section of the South San Joaquin Groundwater Basin

Historically, the semi-confined upper aquifer system was recharged by streambed infiltration and lateral inflow along the basin boundaries. Average annual precipitation in the area is 5 to 11 inches and precipitation in the surrounding mountains can be as high as 65 to 75 inches, although much of it is in the form of snow. In general, peak runoff in the basin lags precipitation by 5 to 6 months (Bertoldi 1991). Natural groundwater replenishment has been supplemented by the percolation of applied agricultural water. The lower confined aquifer is recharged primarily from lateral inflow from the eastern portions of the basin, beyond the eastern extent of the Corcoran Clay. However, in localized areas, recharge also occurs through wells that are perforated above and below the Corcoran Clay, hydraulically connecting the upper and lower aquifers.

The main surface water features in the South San Joaquin Groundwater Basin are the Kern, Kaweah, and Kings Rivers. The agricultural development in the area along with the resultant decline in groundwater levels has caused the majority of the rivers and streams to lose water to the aquifer system.

6.1.5.2 Groundwater Production, Levels, and Storage

Agricultural development began earlier in the South San Joaquin Groundwater Basin than in other parts of the Central Valley. Irrigated agriculture rose to about 1.2 million acres by 1922 and to more than 3.5 million acres by the early 1980s (Reclamation 1997). Groundwater production to support agriculture rose from approximately 3.0 MAF per year in the 1920s to more than 5.0 MAF per year by 1980, although peak groundwater pumping was as high as 8.0 MAF in the late 1950s (Reclamation 1997).

Prior to the large-scale development of irrigated agriculture, groundwater elevations in the South San Joaquin Groundwater Basin ranged from 350 to 400 feet above mean sea level (msl) on the boundaries of the basin, to approximately 200 feet msl in the center of the basin. Groundwater flow converged in the center of the valley and ultimately discharged to Tulare Lake (Williamson 1989). The extensive agricultural development has caused changes in groundwater levels and flow direction. Groundwater levels in the western portion of the basin declined by as much as 400 feet by the 1960s relative to predevelopment conditions. Groundwater levels declined by as much as 100 feet in the southern and central portions of the basin, as far south as Bakersfield. Friant-Kern Canal water was imported to the area in 1949, and CVP and SWP water in the 1960s. Additional CVP water was imported in the mid-1970s. As a result of decline in groundwater use, groundwater levels in some areas have begun to recover. Reductions in surface water deliveries during droughts result in increased groundwater pumping and a corresponding decline in groundwater levels.

In many areas, wells must be screened below the Corcoran Clay layer to extract groundwater from the confined aquifer. The unconfined aquifer above the Corcoran clay layer is not of adequate quality for beneficial use. In Tulare Lake Water Storage District (WSD) in Kings County, for example, it is economical to produce groundwater only from the northeast third of the service area, because of the poor groundwater quality and poor well yields (resulting from the clay layers) in the remaining two-thirds of the district. Even in the third of the district that is productive, wells must be drilled to 1,500 to 2,000 feet bgs to produce quality water. Poor well yields and poor water quality occur in the remaining two-thirds of the district (Tulare Lake 1981).

Figures 6-14 and 6-15 show the 2000 groundwater elevations and the depth to groundwater in the South San Joaquin Groundwater Basin, respectively. Following a period of wet years, groundwater levels in 2000 recovered to 1970 levels throughout the basin. These levels fluctuated substantially between 1970 and 2000 as a result of pumping, drought, groundwater banking, and replenishment projects. Surface water importing and groundwater pumping reductions have caused groundwater levels to rise by over 30 feet since 1970 along the southeast valley margin and in the Lost Hills/Buttonwillow areas. In contrast, excess pumping has resulted in groundwater declines of over 25 feet (relative to 1970 levels) within the vicinity of Bakersfield. Groundwater level declines of 50 feet (relative to 1970 levels) in the McFarland/Shafter areas have been observed (DWR 2002). During 1998 and 1999, groundwater levels in the portion of the Kern Fan Element rose by 30 to 50 feet. This increase is attributed mainly to the local groundwater banking projects in the Kern Fan Element (KCWA 2002).

6.1.5.3 Facilities and Banking Projects in Kern County

Kern County WA is the largest agricultural SWP contractor and the third largest municipal and industrial (M&I) SWP contractor in California. The agency was formed in 1961 and serves as an "umbrella organization" that acquires water from the SWP and sells the water to agencies within the county. Kern County WA must approve of all water that enters or leaves the county and also reserves the right to control flood and storm water, drain and reclaim land, store and reclaim water, protect groundwater quality, and conduct investigations involving water resources. The agency serves as an important intermediate link and resource organization for representing local interests at the State level. Its 13 member agencies include: Berrenda Mesa WD, Lost Hills Water District, Belridge Water Storage District, Semitropic ID, Cawelo WD, Rosedale Rio-Bravo WSD, Buena Vista WSD, Kern Delta WSD, Henry Miller WD, West Kern WD, Wheeler Ridge-Maricopa WSD, Tehachapi Cummings County WD, and Tejon Castaic WD (KCWA 2002).

A complex system of drains, pumps, pipelines, and conveyance facilities within Kern County provides a broad array of options for conveying water. These facilities are used not only for transfers within the county's boundaries, but also as key transport facilities for external water transfers throughout the State of California. The main surface water conveyance facilities in Kern County include the Kern River, California Aqueduct, Friant-Kern Canal, Cross Valley Canal, the Arvin-Edison Canal and Pipeline, and the Kern River-California Aqueduct Intertie. In general, the Friant-Kern Canal transports CVP water from Millerton Lake in Fresno County to the Kern River channel. The Arvin-Edison Canal further conveys Kern River flows and CVP water originating in the Friant-Kern Canal downstream to Arvin-Edison WSD. The Arvin-Edison pipeline conveys water bi-directionally between the District and the California Aqueduct. The Cross Valley Canal, a bi-directional conveyance system, connects the Friant-Kern Canal with the California Aqueduct (Bucher 2002).

Several groundwater banking projects have been established in Kern County and more are planned. The main objectives of the groundwater banking projects are to improve water supply reliability for users within the county and provide storage for partner agencies outside the county. Kern County water agencies store surplus water during wet years and recover the water, if needed, during dry years. The banked water consists primarily of water from the SWP, Friant-Kern water (CVP deliveries), and captured surface flows or flood flows from the Kern River (Bucher 2002).

Groundwater banks that could manage EWA assets in the Kern Fan Element consist of the Berrenda Mesa, Kern Water Bank, and Pioneer Banking Projects. (See Figure 6-18.) These projects are along the Kern River alluvial fan southwest of Bakersfield. The alluvial fan is highly suitable for banking purposes, as it generally consists of permeable river deposits with high well yields that allow quick recovery. These water banks are also near three water sources, the Kern River, the California Aqueduct, and the Friant-Kern Canal.

The Kern Fan Element water banks are operated solely for storing water delivered to participating agencies within Kern County. Banked groundwater in Berrenda Mesa and the Kern Water Bank may be sold to external agencies or acquisition programs such as the EWA at the discretion of the participating agencies listed in Table 6-3**.** Based on the original established operating rules, water stored in the Pioneer Bank may be used only within the county, with the exception of the 25 percent allotment that Kern County WA owns and reserves the right to use at its own discretion (Bucher 2002). Kern County WA has the option of selling a share of this 25 percent to the EWA Project Agencies.

The Semitropic and Arvin-Edison water banks store water from within Kern County, and for agencies outside Kern County. Storage agreements provide benefits to both the bank owner and to the external agency. The water banks provide storage space and facilities for its participating agencies and receive payments in exchange. Storing water in the banks helps alleviate overdraft in the basin. Semitropic is planning to expand its banking operations to the northwest of its current banking facilities and to add another wellfield that would provide an additional 200,000 acre-feet of total annual recovery capacity (Semitropic WSD 2000a). Currently, both Santa Clara Valley WD and Metropolitan WD have water stored in the Semitropic water bank. Arvin-Edison WSD has an agreement with Metropolitan WD in which Arvin-Edison provides Metropolitan WD an allocation of storage space in its groundwater bank for a 25-year period, and in exchange Metropolitan WD has agreed to pay for additional banking facilities. Arvin-Edison's facilities consist of 1500 acres of spreading basins, with over 70 wells concentrated in the central portion of the district along the Arvin-Edison Canal (Lewis 2002).

Table 6-3 lists the operating water banks, associated agencies, and the percent allocation for each participating agency. Table 6-4 lists the maximum operating capacities for each water bank and Table 6-5 lists the amount of groundwater bank water that was in storage as of July 31, 2000.

Table 6-3
Participants and Sponsors of Existing Groundwater Banks

Water Bank	Date of Operation	Owner/ Sponsor	Participants	Allocation
Berrenda Mesa	1983	Berrenda Mesa ID	Belridge WSD Berrenda Mesa WD Lost Hills WD Wheeler Ridge-Maricopa WSD	11.45% 60.90% 9.87% 16.78%
KWB	1995	Kern County WA Joint Powers Authority	Dudley Ridge WD Improvement District 4 Semitropic WSD Tejon-Castaic WD Westside Mutual Water Co. Wheeler Ridge-Maricopa WSD	9.62% 9.62% 6.67% 2.00% 48.06% 24.03%
Pioneer	1995	Kern County WA	Recovery Priority: Belridge WSD Berrenda Mesa WD Improvement District No. 4 Kern County WA Lost Hills WD Semitropic WSD Tejon Castaic WD Wheeler Ridge Maricopa WSD Recharge Priority: Buena Vista WSD Henry Miller WD Kern County WA Kern Delta WD Rosedale Rio Bravo WSD	 12.75% 12.75% 6.50% 25.00% 11.25% 10.50% 0.75% 19.50% 18.75% 18.75% 25.00% 18.75% 18.75%
Arvin-Edison/MWD	1998	Arvin-Edison	MWD[1]	<<TBD>> <<TBD>>
Semitropic	1990	Semitropic	MWD[2] SCVWD Vidler Water Company, Inc. Zone 7 Alameda County WD	35.00% 35.00% 18.50% 6.50% 5.00%

Source: KCWA 2000

1 EWA acquisition would either entail the purchase of MWD or Arvin-Edison banked groundwater (not CVP water) or the purchase/lease of storage space to bank EWA water. The acquisition of water must comply with the banking operation agreements among the participating agencies.

2 EWA acquisition would either entail the purchase of project participant banked groundwater or the purchase/lease of storage space to bank EWA water.

Table 6-4
Summary of Groundwater Bank Project Recovery, Recharge, and Storage Capacities

Project	Area (acres)	Capital cost (1000 $)	Maximum Annual Recovery (AF)	Maximum Annual Recharge (AF)	Estimated Defined Storage (AF)
Berrenda Mesa	369	3,318	46,000	58,000	200,000
COB 2800 Acres	2760	8,350	46,000	168,000	800,000
KWB	19,900	77,100	287,000	450,000	1,000,000
Pioneer	2,253	19,902	98,000	146,000	400,000
Arvin-Edison	130,000	25,000	40,000	140,000	250,000
Semitropic	221,000	134,000	223,000	315,000	1,000,000

Source: KCWA 2000

Table 6-5
Summary of Groundwater Banking and Cumulative Storage as of July 31, 2000

Project	Estimated Maximum Storage (AF)	Current Storage				Remaining Storage Capacity (AF)
		SWP (AF)	Friant - Kern (AF)	Kern River (AF)	Total (AF)	
Direct Recharge						
Berrenda Mesa	200,000	51,000	17,000	34,000	102,000	98,000
COB 2800 Acres	800,000	266,000	161,000	309,000	736,000	64,000
Kern Water Bank	1,000,000	520,000	80,000	291,000	891,000	109,000
Pioneer	400,000	148,000	26,000	82,000	256,000	144,000
Subtotal	2,650,000	1,213,000	284,000	716,000	2,213,000	437,000
District Direct Recharge						
Arvin-Edison WSD/ MWD	250,000	167,000	-	-	167,000	83,000
Semitropic/MWD et all	1,000,000	684,000	-	-	684,000	316,000
Total	3,900,000	2,064,000	284,000	716,000	3,064,000	836,000

Source: KCWA 2000

6.1.5.4 Land Subsidence

As a result of considerable declines in groundwater levels and the hydrogeologic nature of the South San Joaquin Groundwater Basin, land subsidence has been a significant issue in localized areas. In addition to the subsidence observed in the Los Banos-Kettleman City area, discussed in Section 6.1.2.3 North San Joaquin Groundwater Basin, subsidence has been recorded in the Tulare-Wasco area, and the Arvin-Maricopa area (CALFED 2000). Figure 6-16 shows areas of historical subsidence in the South San Joaquin River Valley from 1926 to 1970 and depicts the current monitoring locations.

6.1.5.5 Groundwater Quality

Groundwater quality in the South San Joaquin Basin is comparable to quality in the North San Joaquin Basin. Total dissolved solids concentrations along the east side of the Basin are generally lower than along the west side, where concentrations can exceed 1,500 mg/L (Bertoldi 1991). Portions of the shallow, unconfined aquifer in the western portion of Fresno, Kings, and Kern Counties have been impaired by high TDS concentrations. High boron concentrations have been reported in the north and western portions of the basin, potentially originating from the Diablo Range (Bertoldi 1991). Inadequate drainage is an additional contributing factor. Local agricultural impairments due to high levels of boron, arsenic, selenium, and pesticides occur throughout the Basin (CALFED 2000). Areas north and south of Bakersfield and around the Fresno area have reported nitrate concentrations in excess of 10 mg/L. Municipal use of groundwater is impaired due to high nitrate concentrations in areas throughout the South San Joaquin Basin (Reclamation 1997).

6.2 Environmental Consequences/Environmental Impacts

EWA Project Agency acquisitions and management of EWA assets could affect groundwater resources. To minimize or avoid adverse effects, EWA groundwater-related transfers must comply with three levels of conditions: 1) State regulations, 2) local groundwater management and county ordinances, and 3) the EWA Project Agencies' groundwater purchasing process. Section 6.1.2 described the State regulations and listed local groundwater management plans. This section describes the EWA purchase process, including purchasing agencies review (Section 6.2.7.1) and the groundwater mitigation measures (Section 6.2.7.2).

EWA actions that could affect groundwater resources include the acquisition of water through groundwater substitution, groundwater purchase, and crop idling, in addition to the storage of acquired EWA water in groundwater banking facilities. These actions could alter the existing subsurface hydrology and thus result in a variety of effects in the following categories:

- Groundwater level change;
- Alteration of the existing hydrologic interaction between surface water and groundwater;
- Land subsidence; and
- Degradation of groundwater quality.

Groundwater Levels: Changes in groundwater levels could cause multiple secondary effects. Declining groundwater levels could result in: 1) increased groundwater pumping cost due to increased pumping depth, 2) decreased yield from groundwater wells due to reduction in the saturated thickness of the aquifer, 3) reduced groundwater in storage, and 4) decrease of the groundwater table to a level below the vegetative root zone, which could result in environmental effects.

Surface Water and Groundwater: Groundwater pumping within the vicinity of a surface water body could change the existing interactions between surface and groundwater, potentially resulting in decreased stream flows and levels, with potential adverse effects to the riparian habitat and downstream users. The pumping of groundwater near wetland habitats could also result in adverse environmental effects.

Land Subsidence: Excessive groundwater extraction from confined and unconfined aquifers could result in a lowering of groundwater levels and, in confined aquifers, a decline in water pressure. The reduction in water pressure results in a loss of support for clay and silt beds, which subsequently compress, causing a lowering of the ground surface (land subsidence). The compaction of fine-grained deposits, such as clay and silt, is permanent. The possible consequences of land subsidence are 1) infrastructure damage and 2) alteration of drainage pattern.

Groundwater Quality: Changes in groundwater levels or in the prevailing groundwater flow regime could cause a change in groundwater quality through a number of mechanisms. One mechanism is the potential mobilization of areas of poorer quality water, drawn down from shallow zones, or drawn up into previously unaffected areas. Changes in groundwater gradients and flow directions could also cause (or speed) the lateral migration of poorer quality water. Artificial or enhanced recharge of the aquifer with water of poorer quality, or even different geochemical constituents, could also have an adverse effect on existing conditions. Geochemical differences between the recharged water and groundwater could affect resultant groundwater quality through geochemical processes such as precipitation, bacterial activity, ion exchange, and adsorption.

6.2.1 Assessment Methods

Under each alternative, the EWA Project Agencies would negotiate contracts with willing sellers based on a number of factors, including price, water availability, and location. These factors could change from year-to-year; therefore, the EWA Project Agencies may choose to vary their acquisition strategy in each year. To provide maximum flexibility, this analysis includes many potential transfers when the EWA Project Agencies could likely not need all transfers in a given year. Chapter 2 defines the transfers that are included in this analysis.

A systematic assessment of potential groundwater effects is an important aspect of the implementation of conjunctive use and transfer programs like the EWA. However, such assessments may not be straightforward because several factors complicate quantitative evaluation of groundwater resources. Groundwater resources are not readily visible and are not easily characterized. In addition, most groundwater production is local, self-supplied, and often unmeasured, making it difficult to assess groundwater use in a particular area. Local groundwater management is still evolving with some local agencies actively managing the resource while others are still largely disengaged. The technical and financial resources available to local agencies for implementation of management programs also vary widely.

Transfer programs, such as the EWA, could provide the opportunity to improve local understanding and management of groundwater through additional studies and monitoring that would not have been undertaken in the absence of the transfer. They also could provide the seller with additional financial resources. Although a comprehensive quantitative assessment of groundwater effects is not always possible, available data are generally sufficient for developing a broad understanding of the potential effects of groundwater transfers. This broad understanding, when combined with local management and planning activities, could provide an adequate picture of anticipated effects and help to define potential mitigation needs.

An issue regarding use of groundwater is the extent that groundwater pumped in-lieu of surface water is truly an alternative source to surface water. The close hydrologic interaction of surface water and groundwater makes this determination difficult because increased pumping of groundwater may induce increased recharge from a surface water body, and thereby reduce the amount of surface water that is actually available to downstream users.

Recognizing the limitations of both data availability and the lack of specific details regarding likely EWA Program actions, this analysis is primarily a qualitative one. This analysis assesses potential groundwater effects using two methods: 1) a review of regional groundwater level decline estimates and 2) identification of potential effects and discussion of the existing activities, including application of the EWA groundwater mitigation measures, that would address potential significant impacts. Sections 6.2.1.1 and 6.2.1.2 describe these assessment methods.

6.2.1.1 Regional Groundwater Level Declines

This assessment method includes estimation of the potential regional groundwater levels declines in areas where pumping is expected to be concentrated. These estimates factor in the maximum amount of water that a selling agency could reasonably transfer to the EWA Project Agencies.[10] This analysis compares these groundwater level declines to the average historical and seasonal fluctuations and existing well infrastructure within the selling agency's boundaries. A discussion of groundwater transfers, previous groundwater effects that agencies experienced, and how the agencies managed the effects is also included with this method.

Because a limited amount of site-specific information was available, this analysis method requires a number of assumptions to calculate the potential regional declines. This analysis assumes that: 1) aquifers are unconfined, 2) additional groundwater pumping comes from water in storage, and 3) no change to aquifer inflows occurs as a result of new pumping.

The groundwater declines were calculated using the following equation:

$$\textit{Change in Groundwater Level} = \frac{V}{A\,n}$$

where: V = Volume of groundwater extracted
n = Specific yield
A = Area where pumping is to be concentrated

The resulting estimates are intended to illustrate, on a regional basis, the potential decline in groundwater levels. They do not characterize localized effects near the well or direct hydraulic effects in areas near additional groundwater withdrawals, nor do they incorporate any of the local hydrogeological or hydrological characteristics that ultimately determine the drawdown and account for changes to inflows or outflows.

10 Table 2-5 in Chapter 2 Alternatives provides these amounts.

Regional groundwater level declines are provided here to illustrate the magnitude of regional storage reduction and are not intended to measure significance. This analysis method also does not estimate potential effects related to groundwater quality, local land subsidence, or interaction with surface water. An alternative method, the groundwater mitigation measures, was necessary to address the potential for local groundwater effects.

6.2.1.2 Local Effects and Groundwater Management

The assessment methods examine how local groundwater management would address potential effects to groundwater resources. It is a qualitative analysis intended to address the potential effects on a more local scale than the estimates of regional groundwater level decline described above. For each potential selling agency, this method addresses likely groundwater effects, including groundwater level declines, interaction with surface water, land subsidence, and groundwater quality degradation. This assessment discusses applicable local management plans, county ordinances, and existing monitoring, which selling agencies may use to address potential effects related to EWA groundwater transfers.

6.2.2 Significance Criteria

The following criteria establish the significance of a local adverse groundwater effect. Similar to the CALFED plan programmatic EIS/EIR, groundwater effects would be considered significant at a local level if EWA-related actions would cause one or more of the following:

- A net reduction in groundwater levels that exceeds basin management objectives established for the basin in question, resulting in adverse third party and/or environmental effects;
- Degradation in groundwater quality that threatens to exceed regulatory standards or would substantially impair reasonably anticipated beneficial uses of groundwater; and
- Permanent land subsidence caused by water level declines.

Because of the analysis limitations mentioned below, this document cannot accurately measure the significance of potential adverse effects according to these significance criteria on a site-specific level. Consequently, these effects would be assessed on a site-by-site basis when a transfer to the EWA Project Agencies is to take place. Application of this local assessment should adhere to the framework set forth in the groundwater mitigation measures and in local management policies.

6.2.3 Environmental Consequences/Environmental Impacts of the No Action/No Project Alternative

An analysis of the groundwater resources presented in Section 6.1 indicates that groundwater development would continue to occur during the Stage 1 period of the CALFED plan analyzed in this EIS/EIR. The No Action/No Project Alternative would not change this trend. As water demand continues to increase throughout California, the development of groundwater resources, both through extraction and groundwater banking, would likely increase. As described in the Affected Environment/Existing Conditions (Section 6.1), water agencies are taking initiative to manage their groundwater resources. The No Action/No Project Alternative would result in the same conditions as those described in the Affected Environment.

6.2.4 Environmental Consequences/Environmental Impacts of the Flexible Purchase Alternative

The Flexible Purchase Alternative allows transfers up to 600,000 acre-feet and does not specify transfer limits for the Upstream from the Delta Region or the Export Service Area. The transfer from areas Upstream from the Delta Region would range between 50,000 and 600,000 acre-feet, limited by hydrologic year and conveyance capacity through the Delta. Although potential transfers would not all take place in one year, this section discusses maximum transfers to the EWA from all agencies to provide an effect analysis of the maximum transfer scenario. Similarly, the evaluation includes an analysis of up to 540,000 acre-feet in the Export Service Area to cover the maximum transfer scenario for that region. The following text presents evaluations of the effects of the Flexible Purchase Alternative by each of the groundwater subbasins.

6.2.4.1 Upstream from the Delta Region

EWA Project Agency acquisitions that could affect groundwater resources Upstream from the Delta Region include groundwater substitution, groundwater purchase, and crop idling. The effects associated with each of these acquisitions are groundwater level declines, alteration of surface and groundwater hydrology, land subsidence, and changes in groundwater quality.

This discussion covers the effects of crop idling at a regional scale and the potential effects of groundwater substitution and groundwater purchase at the local scale. Section 6.2.4.1.1 covers the Redding Groundwater Basin. Section 6.2.4.1.2 covers the Sacramento Groundwater Basin, which includes the Colusa, East Butte, West Butte, East Sutter, North Yuba, South Yuba, and North American subbasins.

6.2.4.1.1 Redding Groundwater Basin

EWA acquisition of Sacramento River Contract water in the Redding groundwater subbasin via groundwater substitution could affect groundwater hydrology. The potential effects would be decline in groundwater levels, interaction with surface water, land subsidence, and water quality impacts. Groundwater substitution would most likely be concentrated in Anderson-Cottonwood ID.

***Groundwater Levels*:** Groundwater substitution for the EWA asset acquisition could result in temporary declines of groundwater levels in excess of seasonal fluctuations. Historically, groundwater levels within Anderson-Cottonwood ID have remained relatively stable, as shown on Figure 6-20. The most noticeable declines in some wells occurred during the droughts of 1976-1977 and 1986-1994. These declines were followed by groundwater recovery to pre-drought levels. Because of the aquifer's relatively short recovery period, an EWA-related transfer would likely have a minimal effect on long-term groundwater level trends (DWR Northern District 2002).

Figure 6-20 also shows the area in which the potential seller, Anderson-Cottonwood ID, would most likely pump water using agency owned wells. The selection of this area was based on the wells that were proposed by Anderson-Cottonwood ID for the Forbearance transfer in 2001 (although a proposal was made, the transfer did not occur). Table 6-6 compares the estimated potential drawdown caused by an EWA Project Agency one-year groundwater transfer with historical fluctuations.

Table 6-6
Flexible Alternative Estimate of the Groundwater Drawdown for the Redding Basin

EWA Acquisition Range	10,000 to 40,000
Estimated Regional Drawdown based on Range of Possible One-Year EWA Asset Acquisition	5 to 19 feet
Normal Year Seasonal Fluctuations	2-3 feet (unconfined) 2 – 5 feet (semi confined – confined)
Drought Year Seasonal Fluctuations	4-10 feet (unconfined) 4-16 feet (semi-confined and confined)

Source for groundwater level fluctuations: DWR Northern District 2002

In normal and above-normal years, the Redding Groundwater basin recharges fully after the irrigation season, indicating that the basin is not being overdrafted. Seasonal groundwater fluctuations range from 2 to 3 feet in unconfined aquifers and 2 to 5 feet in semi-confined to confined aquifers in normal years. During drought years, unconfined aquifer levels may fluctuate by as much as 10 feet, while semi-confined and confined aquifer levels may fluctuate as much as 16 feet.

As shown in Table 6-6, the potential groundwater level declines resulting from EWA Project Agency acquisitions would range from 5 to 19 feet in addition to seasonal fluctuation. Potential declines associated with the higher end of EWA Project Agency acquisition range would be relatively large when compared to the seasonal fluctuations, indicating the potential for adverse effects. The potential for adverse drawdown effects would increase as the amount of extracted water increased. The potential for adverse effects would be higher still during dry years, when baseline fluctuations are already large and groundwater levels may be lower than normal.

Well data provided in Table 6-7 show that 50 percent of domestic wells are relatively shallow, with a depth of 90 feet or less. Because shallow wells would be affected by drawdown before deeper wells would, the potential for adverse drawdown effects is greater in areas with a greater number of shallow wells.

Table 6-7
Well Data for Anderson-Cottonwood Irrigation District

Well Type	*Number of Wells*	*Average Well Depth (ft)*	*Depth Distribution*
Domestic	1,718	95	50% - 90 ft depth or less
			20% - 52 ft depth or less
			10% - 36 ft depth or less
Irrigation	49	223	50% - 190 ft depth or less
			20 % - 80 ft depth or less
			10% - 45 ft depth or less
Municipal	21	223	Not calculated
Industrial	29	216	Not calculated
Other	50	212	Not calculated

Source: DWR Northern District 2002

Increased groundwater pumping could also cause localized declines of groundwater levels, or cones of depression, near pumping wells. These declines would likely be larger than those indicated in Table 6-6, possibly causing effects to wells within the cone of depression.

DWR currently monitors groundwater levels in six wells in Anderson-Cottonwood ID (DWR Northern District 2002). In 2000, CALFED agencies awarded Anderson-Cottonwood ID a grant as part of the Conjunctive Use Program.[11] This grant was for the construction of 12 monitoring wells, followed by the installation of 5 extraction wells. The 12 monitoring wells would be used to evaluate canal seepage; the direction and rate of groundwater flow; changes in water levels; and the economic, institutional, and environmental effects within the extraction area (Swearingen 2002).

EWA groundwater substitution transfers could result in groundwater declines in excess of seasonal variation and these effects on groundwater levels could be potentially significant. To reduce these effects, the groundwater mitigation measures specify that Anderson-Cottonwood ID establish a monitoring program in addition to existing monitoring within the district prior to an EWA-related groundwater substitution transfer. Furthermore, the groundwater mitigation measures require that if effects are shown or reported to be occurring, Anderson-Cottonwood ID would be responsible for implementing mitigation measures. These mitigation measures would reduce effects to less-than-significant levels.

Past Groundwater Transfers: Anderson-Cottonwood ID proposed to transfer 1,540 acre-feet of water via groundwater substitution to Westlands WD under the 2001 Forbearance Agreement. However, the transfer proposal was not accepted. As shown on Table 2-5 in Chapter 2, Anderson-Cottonwood ID could transfer 10,000 to

11 The CALFED Conjunctive Use Grant Program was established to encourage the development of conjunctive use projects, which would improve local water management and ultimately, water supply reliability for the Bay-Delta system.

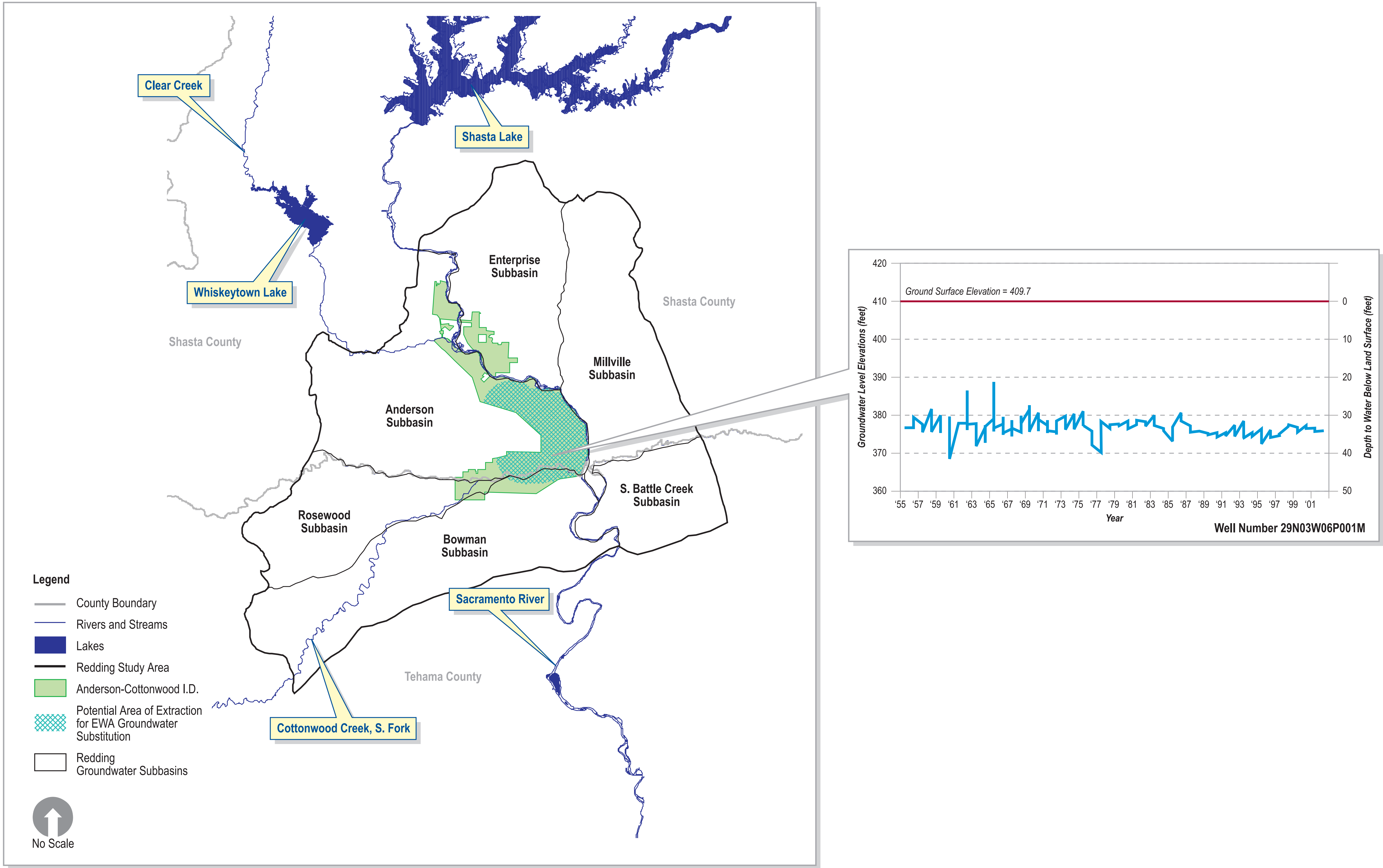


Figure 6-20
Groundwater Levels and Anderson-Cotton I.D. in the Redding Basin

40,000 acre-feet to the EWA Project Agencies. Anderson-Cottonwood ID plans to expand its conjunctive use capabilities, which would furnish the district the capacity to provide up to 40,000 acre-feet. This initial phase of the conjunctive use project is the installation of five extraction wells through the district's 2000 DWR grant, which would add 10,000 acre-foot of supplemental supply to the district (Swearingen 2002).

Interaction with Surface Water: Pumping has the potential to reduce channel flows in Cottonwood Creek, Anderson-Cottonwood Main Canal, and the Sacramento River. The reduction in flows in the Sacramento River could adversely affect riparian and aquatic habitats and downstream water users. Reductions to the Main Canal could adversely affect Anderson-Cottonwood ID's distribution system.

Groundwater pumping for EWA groundwater substitution transfers could reduce flows in nearby surface water bodies and these effects could be potentially significant. To reduce these effects, the groundwater mitigation measures require evaluation of measures to avoid and minimize all such potential effects prior to an EWA-related transfer. Through the Well Review process identified in the groundwater mitigation measures, the purchasing agency would review the location and screened interval of the proposed production wells. Production wells within 2 miles of a surface water body would need to meet well depth criteria if there were insufficient data to show that pumping would not result in adverse effects. Furthermore, the Well Review may determine that pumping activities should be limited to a specified depth in some areas, to avoid hydraulic interaction between pumping and overlying surface water systems. In addition to the Well Review, the groundwater mitigation measures provide guidance for the establishment of a local monitoring and mitigation program, designed to identify and mitigate local effects. These mitigation measures would reduce effects to less-than-significant levels.

Land Subsidence*:* Groundwater extraction under the Flexible Purchase Alternative would decrease groundwater levels, increasing the potential for localized land subsidence. Although subsidence has never been monitored in the Redding Groundwater Basin and there is no documented evidence of subsidence, it is a potential effect. As mentioned in Section 6.1.3.1, the groundwater basin west of the Sacramento River includes the Tehama Formation, which has exhibited subsidence in Yolo County (Dudley 2002). As long as EWA-related asset transfers would not cause the groundwater to decline below historical levels, the potential for subsidence would be minimized.

EWA groundwater substitution transfers could decrease groundwater levels that could cause potentially significant effects on land subsidence. To reduce these effects, the groundwater mitigation measures stipulate that all sellers to the EWA Project Agencies have a monitoring and mitigation program in place to address potential land subsidence effects. The level of monitoring needed to monitor land subsidence may be negotiated between the review team and the selling district prior to the transfer. These mitigation measures would reduce effects to less-than-significant levels.

Groundwater Quality*:* Migration and distribution in water supply systems of reduced quality groundwater would be two potential water quality effects associated with increased groundwater withdrawals from Anderson-Cottonwood ID.

The Migration of Reduced Quality Groundwater. Although groundwater in this area is generally of good quality, elevated levels of iron, manganese, nitrate, and TDS have been detected in some localized areas of the basin. High levels of boron have been detected in the southern portion of the Redding basin and areas of high salinity are prevalent along the basin's margins (DWR 2002 and DWR Northern District 2002). The movement or migration of reduced quality water into previously unaffected areas through groundwater pumping is a relatively slow process, it is not likely to be accelerated significantly or altered by short-term fluctuations in groundwater levels.

Distribution of Reduced Quality Groundwater: The quality of groundwater extracted from the wells of Anderson-Cottonwood ID could be different quality from the surface supply allotment the district normally receives; however, it is of adequate quality for agricultural purposes. If there were to be unanticipated adverse groundwater quality effects as a result of the transfer, the groundwater mitigation measures specify that Anderson-Cottonwood ID be responsible for monitoring this degradation and mitigating the adverse effects. No significant effects related to the distribution of reduced quality water would be likely; however, the mitigation measures would reduce any potential effects to less than significant levels.

Multi-Year Acquisition and Purchase During Dry Years: As discussed above, groundwater data indicates that during normal and wet years groundwater levels tend to recover to pre-irrigation levels. During dry years, however, groundwater use is typically increased and percolation from natural runoff is often lower than normal, causing groundwater levels to decline more than in normal and wet years. Furthermore, when dry years occur consecutively, groundwater levels would likely decline throughout the dry period and then recover only after several normal or wet years. Historical water-level data illustrates this trend: groundwater levels tend to recover during normal and wet years, but the likelihood of full recovery decreases during dry years. Therefore, if EWA groundwater transfers were to occur for several consecutive years during a dry period, the transfer could contribute to groundwater level declines over a period of several years. Without sufficient wet season recovery, this decline could result in significant impacts.

The EWA's effects on groundwater levels during multi-year transfers or during dry years could be potentially significant. To reduce these effects, local county ordinances and the groundwater mitigation measures provide guidelines to evaluate groundwater levels prior to each EWA transfer. If groundwater levels prior to a proposed purchase were low relative to previous years, a pre-purchase evaluation would be performed to evaluate regional groundwater levels and potential drawdown. (See Section 6.2.7.2 for further details.) If the Review Team concluded that significant regional effects would be probable, the EWA Project Agencies would not purchase water via groundwater substitution for the given hydrologic year, or they would request changes in the transfer mechanisms from the willing sellers. In contrast, if the Review Team concluded that the likelihood of regional effects would be minimal then the transfer could commence. The groundwater mitigation measures further stipulate that all sellers to the EWA Project Agencies have a monitoring and mitigation program in place to address adverse effects should they occur. These mitigation measures would reduce effects to less than significant levels.

Local Groundwater Management and Monitoring: A variety of activities and local management policies could assist in minimizing effects associated with groundwater transfers. Tehama County and the Redding Area Water Council have developed AB3030 plans for Tehama County and the Redding Basin, respectively. (Table 6-2 shows the basic components included in the plans.) Tehama County's AB3030 plan is unique in that the plan proposes management levels based on "trigger levels" for each subbasin. These levels entail a passive, limited, or active level of management, depending on the degree to which the trigger level is exceeded. The objective of this strategy is to limit groundwater management to the level that is least intrusive to the local landowner while still managing groundwater resources effectively (Keppen 1996). Tehama County is working to implement its plan, but has not yet started developing trigger levels (DWR Northern District 2002). Table 6-2 summarizes the components in each plan. In addition to these groundwater management plans, both Shasta County and Tehama County have ordinances addressing groundwater transfers.

- *Shasta County Ordinance No. SCC 98-1, 1998:* This county ordinance requires permits prior to the extraction of groundwater for direct or indirect use. Except in certain outlined circumstances, this ordinance includes all groundwater that could be substituted for surface water and exported from the county. Permit applicants must fund the necessary environmental reviews. The public is notified of the permit filing, and notices are sent to all interested parties and to the owners of overlying or adjacent lands. A Commission, consisting of nine appointed representatives of Shasta County, decides whether to approve the permit if the environmental review determines that the proposed action would not result in any significant adverse impacts (DWR Northern District 2002).

- *Tehama County Urgency Ordinance No. 1617:* This county ordinance requires a permit for groundwater extraction for transfers within the county or outside of county borders. Permits would be granted only after review of potential effects have shown that well operation would not result in overdraft, saltwater intrusion, or water mining, and the operation would not cause adverse effects on the transmissivity of the underlying aquifer or the water table. The ordinance also prohibits the operation of wells constructed after 1991 if the radius of influence extends beyond the boundaries of the property or beyond the boundaries of the owner's adjacent properties (Board of Supervisors of the County of Tehama, 1994).

In addition to the ordinances and plans mentioned above, in 2000 and 2001, the Redding Area Water Council, in conjunction with the Shasta County Water Agency, developed a groundwater model for the Redding Groundwater Basin. This model simulates the changes in groundwater levels and stream stage in response to various hydrologic stresses and land use for the area. The model was calibrated to a given set of land use and groundwater level data from monitoring wells. The Redding Area Water Council uses the model to simulate groundwater responses to planning scenarios in the Redding basin-wide water resources plan. The model serves as a regional planning tool and assists in planning and predicting the potential effects of smaller scale projects (Wedemeyer 2002).

The EWA Project Agencies would not make purchases that interfere or conflict with the local management efforts described above, and would not purchase water from an agency unless that agency has successfully complied with the groundwater mitigation measures. Therefore, in order for the transfers discussed above to take place, Anderson-Cottonwood ID would implement the well review, monitoring, and mitigation measures outlined in the groundwater mitigation measures. *Consequently, EWA groundwater substitution transfers in the Redding groundwater subbasin could have potentially significant effects on groundwater levels, groundwater quality, surface water, and land subsidence. However, the groundwater transfers will be conducted in accordance with local management requirements and EWA groundwater mitigation measures (as discussed in Section 6.2.7) that will reduce these impacts to less than significant.*

6.2.4.1.2 Sacramento Groundwater Basin Crop Idling

EWA acquisition of Sacramento River contractor water via crop idling of rice could decrease applied water recharge to the local groundwater system underlying the barren (idled) fields. Specific potential effects would be a decline in groundwater levels.

Figure 6-21 shows the areas of rice production that could be idled in counties Upstream from the Delta Region. The economic analysis in this EIS/EIR (Chapter 11) limits EWA crop idling transfers to 20 percent of the land within each county that would have been cropped with rice. Reducing applied water would result in a loss of recharge to the Sacramento Groundwater Basin. This loss, however, would be relatively small when compared to the total of amount of water that recharges the Sacramento Groundwater Basin. A large portion of the total recharge to the Basin occurs through precipitation and runoff over the spring and winter months. As illustrated by the hydrographs in Figures 6-22 through 6-27, groundwater levels generally recover during the rainy winter season. A 20 percent reduction in applied water recharge would result in a much smaller reduction of overall Basin recharge and would be well within the variability of annual recharge.

Furthermore, the land used for rice production consists of low permeable soils. A substantial portion of the applied water does not percolate to the underlying aquifer, but rather discharges to the farmer's surface drainage system.

A reduction in applied recharge because of idled rice fields could have effects on groundwater recharge and levels; however this action would probably not substantially reduce the percentage of applied water that recharges the underlying Basin. *Consequently, the reduction in groundwater recharge as a result of rice idling would be less than significant.*

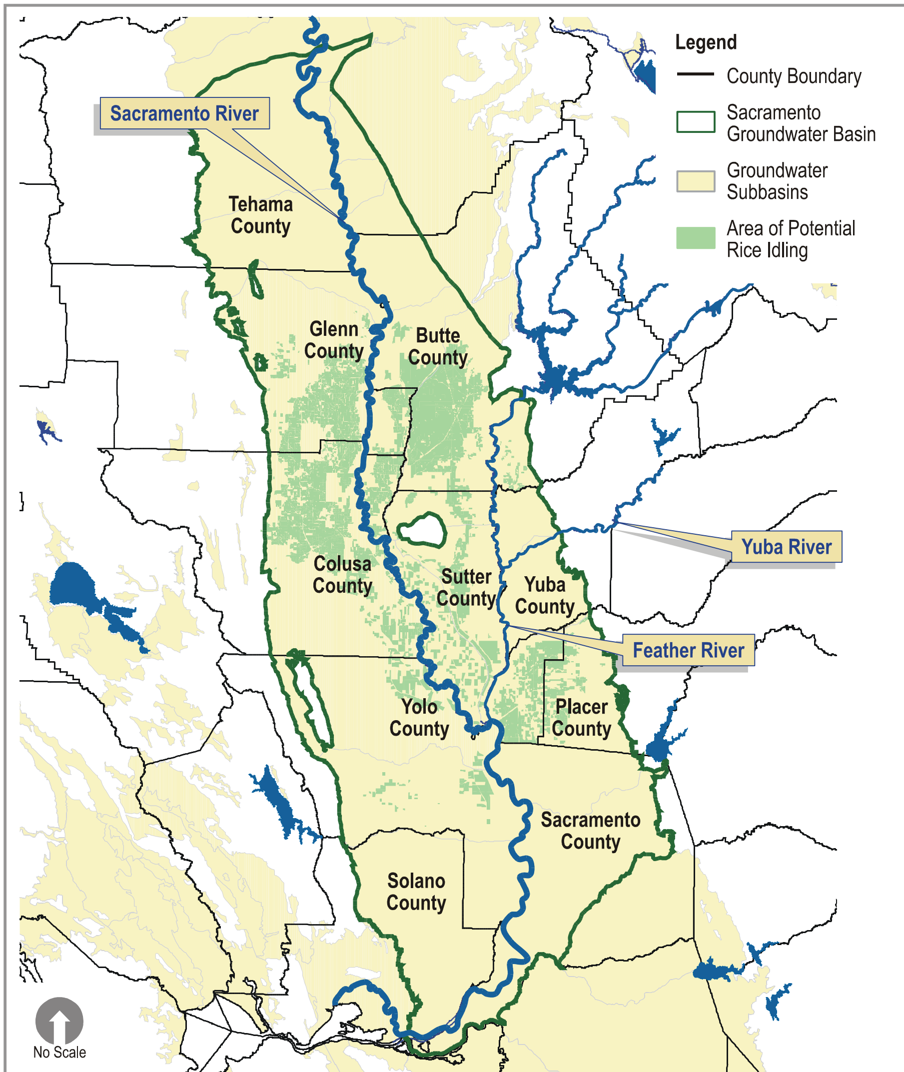


Figure 6-21
Potential Areas of EWA Rice Idling in the Sacramento Valley

Colusa Groundwater Subbasin Groundwater Substitution

EWA Project Agency acquisition of Sacramento Contractor water in the Colusa groundwater subbasin via groundwater substitution could affect groundwater hydrology. The potential effects would be decline in groundwater levels, interaction with surface water, land subsidence, and water quality impacts. Groundwater substitution would most likely be concentrated in Glenn-Colusa ID and Reclamation District 108 (RD 108).

Groundwater levels*:* Groundwater substitution may result in temporary declines of groundwater levels. Historically, groundwater levels have remained relatively stable within Glenn Colusa ID and RD 108, as shown on Figure 6-22**.** In some areas, groundwater levels decreased during the droughts of 1976-1977, and 1987-1994 but rebounded in the following wet years (DWR 2002). Groundwater levels tend to decrease during the irrigation season and rebound in the wet winter months. A large portion of recharge in the basin is likely through percolation of natural runoff and the percolation of applied water and irrigation water in unlined canals (DWR Northern District 2002). Because of the aquifer's relatively short recovery period, an EWA-related transfer would likely have a minimal effect on long-term groundwater level trends. It is also likely that groundwater substitution pumping would be concentrated in the northern portion of Glenn Colusa ID, near the Stony Creek Fan area, which recharges relatively rapidly in winter.[12]

Groundwater substitution for EWA asset acquisition could result in temporary drawdown that exceeds historical seasonal fluctuations. Table 6-8 compares the estimated potential drawdown resulting from a one-year EWA transfer with historical fluctuations for the Glen-Colusa ID and RD 108. Figure 6-21 shows the areas for which the regional declines are estimated**.** These areas were selected based on the wells used for the 2001 Forbearance Agreement transfer. Groundwater substitution pumping within Glenn Colusa ID was allocated proportionally according to the number of wells in each area – north, central, and south. The majority of the wells are concentrated in the northern part of the district.

Table 6-8
Flexible Alternative Estimate of the Groundwater Drawdown in the Colusa Subbasin

	Reclamation District 108	***Glenn Colusa ID***		
EWA Acquisition Range	5 TAF	20-60 TAF		
Estimated Regional Drawdown based on Range of Possible One-Year EWA Asset Acquisition (feet)	3	North area	Central area	South area
		3 to 10	1 to 3	1 to 2
Normal Year Fluctuations	2 to 5 feet (unconfined) 6-12 feet (semi-confined)	1 to 6 feet (unconfined) 2-20 feet (confined)		
Drought Year Fluctuations:	8-12 feet (unconfined)	2 to 12 feet (unconfined) 3-30 feet (confined)		

Source for annual fluctuations: DWR 2001

As shown in Table 6-8, the potential groundwater level declines resulting from the EWA acquisitions would range from one to ten feet in addition to seasonal fluctuation. The magnitude of this potential drawdown is within the range of seasonal fluctuations. According to well data for Glenn Colusa ID (Table 6-9), 60 percent of the district's domestic wells and 10 percent of their agricultural wells are 110 feet deep, or shallower. It is unlikely that the transfers would result in regional effects to existing wells.

---

[12] The Stony Creek Fan system is in the northern portion of the Colusa subbasin, extending from the Black Butte Reservoir to the City of Willows, northeast from the City of Willows to the Sacramento River, and north beyond the Tehama County border. This system comprises sandy alluvial deposits with higher permeability and recharge rates than the less permeable, clay-type soils in the southern portions of the subbasin.

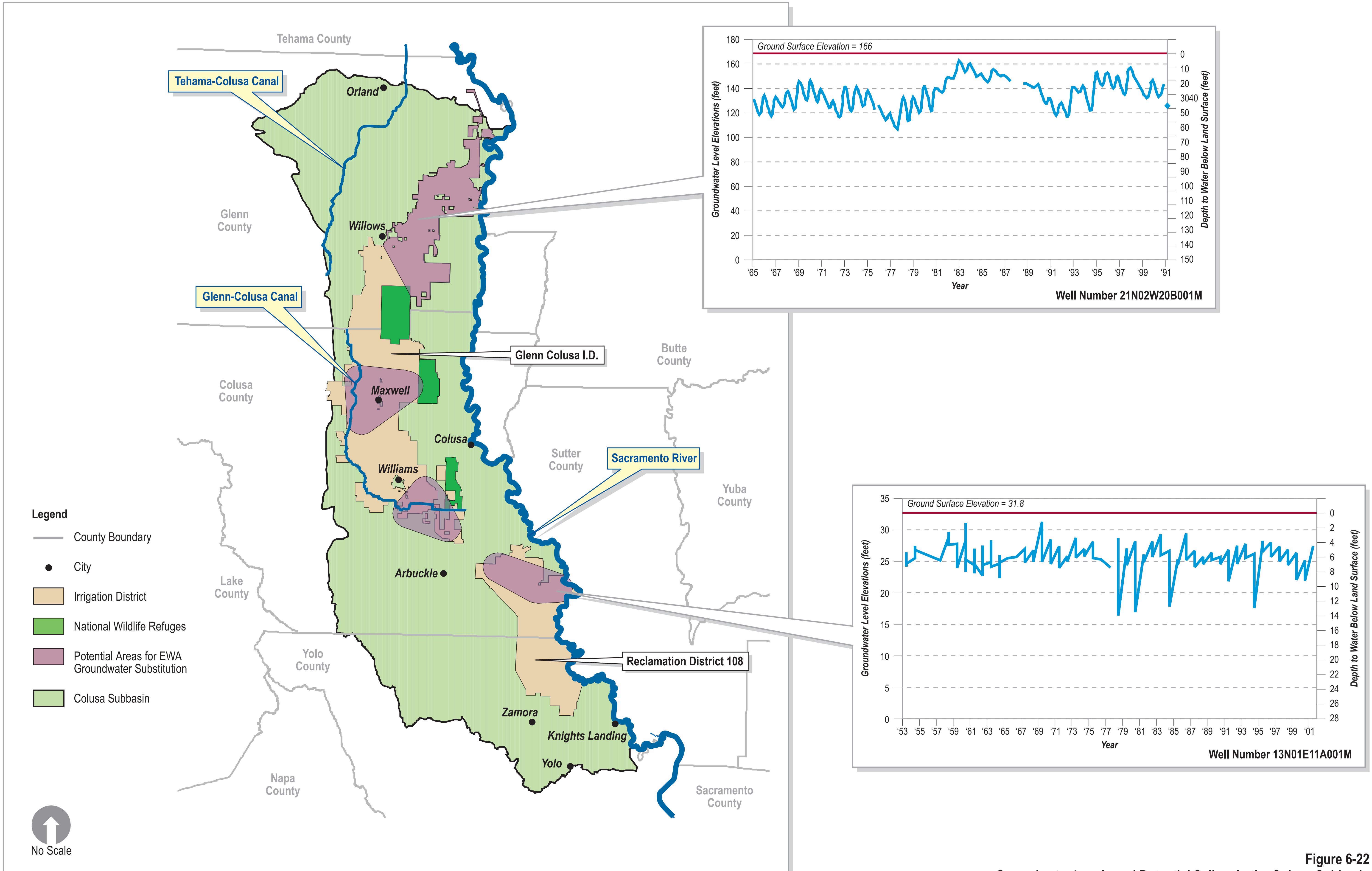


Figure 6-22
Groundwater Levels and Potential Sellers in the Colusa Subbasin

Table 6-9
Glenn Colusa ID and Reclamation District 108 Well Information

Type of Well	*Number of Wells/Average Depth in feet*		*Depth Distribution of GCID Wells*
	Glenn Colusa ID	**RD 108**	
Domestic	414 wells Average 136 ft	20 wells Average 194 ft	50% - 110 ft depth or less 20% - 70 ft depth or less 10% - 55 ft depth or less
Irrigation	301 wells Average 285 ft	23 wells Average 461 ft	50% - 250ft depth or less 20 % - 160 ft depth or less 10% - 110 ft depth or less
Municipal	14 wells Average 502 ft	1 well Average 223 ft	Not calculated
Industrial	17 wells Average 317 ft	2 wells Average 288 ft	Not calculated
Other	148 wells Average 163 ft	73 wells Average 104 ft	Not calculated

Source: DWR Well Completion Reports (DWR Northern District 2002)

Increased groundwater pumping could also cause localized declines of groundwater levels, or cones of depression, near pumping wells. These declines could be larger than those indicated in Table 6-8, possibly causing effects to wells within the cone of depression.

EWA groundwater substitution transfers could result in groundwater declines in excess of seasonal variation and these effects on groundwater levels could be potentially significant. To reduce these effects, the groundwater mitigation measures specify that Glenn Colusa ID and RD 108 establish monitoring programs for an EWA groundwater substitution transfer. The programs would monitor groundwater level fluctuations within the local pumping area and if effects were to be reported, Glenn Colusa ID and RD 108 would implement appropriate mitigation measures. These mitigation measures would reduce effects to less-than-significant levels.

Past Groundwater Transfers: Table 6-10 summarizes the past transfers conducted by Glenn Colusa ID and RD 108. During the Forbearance Agreement groundwater substitution transfer in 2001, a landowner outside the Glenn Colusa ID border claimed that his well was affected. Technical evaluation, conducted in accordance with Glenn County's Basin Management Objective (BMO) ordinance (see Groundwater management sections below) and financed by Glenn Colusa ID, indicated that the effect was not due to the Forbearance transfer but rather due to pumping by a groundwater users upgradient of the affected well as well as a reduction in applied surface water.

Table 6-10
Groundwater Transfers in Glenn-Colusa ID and Reclamation District 108

	Reclamation District 108		Glenn Colusa ID	
	Mechanism	**Amount**	**Mechanism**	**Amount**
Potential EWA Acquisition	3 district wells	5 TAF	Voluntary	20-60 TAF
1991 State Drought Water Bank	3 district wells	6.8 TAF	–	–
1992 State Drought Water Bank	–	–	Voluntary	5 TAF
2001 Forbearance Agreement[1]	3 district wells	14.8 TAF	Voluntary	38.2 TAF

[1] During the 2001 Forbearance Agreement 32,705 AF and 5,000 AF was transferred via crop idling for Glenn Colusa ID and RD 108, respectively.

RD 108 transferred a larger amount of water during the 2001 Forbearance Agreement than the amount proposed under the Flexible Purchase Alternative. No impacts were identified as a result of the 2001 transfer. Glenn Colusa ID's maximum amount under the Flexible Purchase Alternative of 60,000 acre-feet would exceed historical transfer amounts.

Interaction with Surface Water: Pumping close to the Sacramento River, along the eastern border of the subbasin, and close to tributaries could reduce channel flows. This reduction in channel flows could adversely affect the riparian and aquatic habitats as well as downstream water users. Three wildlife refuges occur in the Colusa subbasin. Pumping activities could drain or interrupt the water supply, adversely affecting these habitats.

Groundwater pumping for EWA groundwater substitution transfers could reduce flows in nearby surface water bodies and these effects could be potentially significant. To reduce these effects, the groundwater mitigation measures require assessment of measures to avoid and minimize all such potential effects prior to an EWA asset transfer. Through the Well Review process of the groundwater mitigation measures, the purchasing agency would review the location and screened interval of the proposed production wells. Production wells within 2 miles of a surface water body would need to meet well depth criteria if there were insufficient data to show that pumping would not result in adverse effects. Furthermore, the Well Review may determine that pumping activities should be limited to a specified depth in some areas, in order to avoid hydraulic interaction between pumping and overlying surface water systems. In addition to the well review, the groundwater mitigation measures also provide guidance for the establishment of a local monitoring and mitigation program, designed to identify and mitigate local impacts. These mitigation measures would reduce effects to less-than-significant levels.

Land Subsidence: Groundwater extraction for the EWA asset acquisition would decrease groundwater levels, increasing the potential for subsidence. As shown on Figure 6-9, the majority of the Colusa subbasin has areas of documented historical subsidence and areas of possible historical subsidence. As discussed in Section 6.1.3.2, land subsidence monitoring just south of RD 108 has detected localized subsidence. The southern portions of Glenn-Colusa ID and RD 108 may have also experienced local subsidence (Figure 6-9). Recently, one of RD 108's southern canals required repair because of a loss of freeboard that was linked to subsidence (Bair 2002).

Land subsidence monitoring within the vicinity of the Colusa subbasin includes Yolo County's countywide global positioning system. Additional subsidence monitoring may be necessary, depending on the hydrology, expected groundwater use for an irrigation season, and the planned extraction by Glenn-Colusa ID and RD 108 for the Flexible Purchase Alternative. EWA groundwater substitution transfers could decrease groundwater levels that could cause potentially significant effects on land subsidence. To reduce these effects, the groundwater mitigation measures stipulate that all sellers to the EWA Project Agencies have a monitoring and mitigation program in place to address potential land subsidence effects. The level of monitoring for land subsidence would be negotiated between the Review Team and the selling agency prior to the transfer. These mitigation measures would reduce effects to less-than-significant levels.

Groundwater Quality: The migration of reduced quality water, agricultural use of reduced quality water, and the distribution of reduced quality water are three types of potential water quality impacts associated with increased groundwater withdrawals related to EWA asset acquisition and management.

Migration of Reduced Quality Groundwater. Although groundwater quality in the area is sufficient for most agricultural and municipal purposes, elevated levels of manganese, fluoride, boron, magnesium, sulfate, sodium, iron, nitrates, TDS, ammonia, and phosphorus have been detected in localized areas throughout the Colusa subbasin (DWR 2002 and DWR Northern District 2002). Inducing the movement or migration of reduced quality water into previously unaffected areas through groundwater pumping is not likely to be a concern unless groundwater levels and/or flow patterns are substantially altered for a long period of time. EWA groundwater extraction would be limited to short-term withdrawals during the irrigation season and EWA extraction near areas of reduced groundwater quality concern would be avoided through the groundwater mitigation measures Well Review process. (See Section 6.2.7.2 for more details.) Consequently, adverse effects from the migration of reduced groundwater quality would be anticipated to be minimal.

On-farm Use of Reduced Quality Groundwater: Glenn-Colusa ID farmers that may participate in any EWA groundwater substitution transfers could experience changes in water quality as they switch from surface water to groundwater. However, groundwater quality is good for most agricultural and municipal purposes throughout the subbasin and potential regional impacts would be minimal.

Distribution of Reduced Quality Groundwater: Groundwater extracted from RD 108's three wells may be of reduced quality relative to the surface supply allotment the district normally receives. However, groundwater quality is normally adequate for agricultural purposes. Glenn-Colusa ID and RD 108's monitoring programs for an EWA groundwater substitution transfer would monitor groundwater quality within the local pumping area. If adverse effects related to the degradation of groundwater quality from the transfer occurred, the groundwater mitigation measures specify that Glenn Colusa ID and RD 108 would be responsible for monitoring this degradation and mitigating any adverse effects. No significant impacts related to the distribution of reduced quality water would therefore be likely.

Multi-Year Acquisition and Purchase During Dry Years: As discussed above, in many areas that may participate in the EWA Program, groundwater data indicates that during normal and wet years groundwater levels tend to recover to pre-irrigation levels. During dry years, however, groundwater use is typically increased and percolation from natural runoff is often lower than normal, causing groundwater levels to decline more than in normal and wet years. Furthermore, when dry years occur consecutively, groundwater levels are likely to decline throughout the dry period and then only recover after several normal or wet years. Historical water-level data illustrates this trend: groundwater levels tend to recover during normal and wet years, but the likelihood of full recovery decreases during dry years. Therefore, if EWA groundwater transfers were to occur for several consecutive years during a dry period, the transfer could contribute to the groundwater levels declining over a period of several years. Without sufficient wet season recovery, this decline could result in significant impacts.

The EWA's effects on groundwater levels during multi-year transfers or during dry years could be potentially significant. To reduce these effects , local county ordinances and the groundwater mitigation measures provide guidelines to evaluate groundwater levels prior to each EWA transfer. If groundwater levels prior to a proposed purchase were low relative to previous years, a pre-purchase evaluation would be performed to evaluate regional groundwater levels and potential drawdown. (See Section 6.2.7.2 for further details.) If the Review Team concluded that significant regional effects would be probable, the EWA Project Agencies would not purchase water via groundwater substitution for the given hydrologic year, or they would request changes in the transfer mechanisms from the willing sellers. In contrast, if the Review Team concluded that the likelihood of regional effects would be minimal then the transfer could commence. All sellers to the EWA Project Agencies should have a monitoring and mitigation program in place to address adverse effects should they occur. These mitigation measures would reduce effects to less than significant levels.

Local Groundwater Management and Monitoring: A variety of activities and local management policies could assist in minimizing effects associated with groundwater transfers. DWR monitors groundwater levels semiannually in 98 wells and groundwater quality in 30 wells throughout the Colusa subbasin. The Department of Health Services also monitors for groundwater quality in 134 wells throughout the subbasin (DWR 2002). Furthermore, Glenn Colusa ID and RD 108 have AB3030 Groundwater Management Plans (Table 6-2 shows the components included in the plans) and Glenn, Yolo, and Colusa Counties have adopted county ordinances that requires permits for groundwater transferred out of county borders. These ordinances are discussed below.

The Colusa County Ordinance No. 615 adds Chapter 43, Groundwater Management, to the county code. The ordinance prohibits direct or indirect[13] extraction of groundwater for transfer outside county boundaries without permit approval, except in certain circumstances. The ordinance does have an exemption process that would allow transfers to occur without obtaining a permit. The permit approval process includes a public and environmental review. Permits would only be approved after the environmental review determines that the proposed action would not result in the following: 1) overdraft or increased overdraft, 2) damage to aquifer storage or transmissivity, 3) exceedance of the annual yield or foreseeable injury to beneficial overlying groundwater users and property users, 4) injury to water replenishment, storage, or restoration projects, and 5) noncompliance with Water Code Section 1220. Three-year permits may also impose additional conditions to avoid adverse effects. Violators of this permitting process may be subject to a fine (Colusa County 1999).

Yolo County Export Ordinance No. 1617 is similar to the Colusa County Ordinance described above. Indirect or direct export of groundwater outside Yolo County requires a permit. The Director of Community Development may review the permit application with the affected county department, DWR, RWQCB, and any other interested local water agency neighboring the area of the proposed action. Following a CEQA environmental review and a public review, the Board of Supervisors of Yolo County may grant the permit as long as the evidence supports that the extraction would not cause 1) adverse effects to long-term storage and transmissivity of the aquifer, 2) exceedance of safe yield unless it is in compliance with an established conjunctive use program, 3) noncompliance with Water Code section 1220, and 4) injury to water replenishment, storage, or restoration projects. The board may impose additional conditions to the permit to ensure compliance with the aforementioned criteria. This ordinance, like the Colusa Ordinance, subjects violators to fines (Yolo County 1996).

Glenn County Ordinance No. 1115 calls for the development of BMOs and a monitoring network designed to detect changes in groundwater level, quality, and land subsidence. This strategy defines the acceptable range of groundwater levels,

---

13 In an indirect groundwater extraction, water users transfer their surface water supplies and substitute groundwater to meet their needs.

groundwater quality, and inelastic land subsidence that could occur in a local area without causing significant adverse effects. If the Technical Advisory Committee detects noncompliance, it is to report the noncompliance to the Water Advisory Committee and inform the public. The Technical Advisory Committee then conducts a technical evaluation to determine why the BMO was exceeded and, following negotiation with all parties involved, makes recommendations for resolving the issue. If negotiations to re-establish BMO compliance do not result in a timely resolution, the Water Advisory Committee may provide recommendations to the Board of Supervisors of Glenn County that the pumping should be terminated until compliance is obtained (Glenn County Board of Supervisors 1999).

According to the Glenn County Ordinance, groundwater level monitoring is to be done at least three times a year: once prior to the irrigation season, once during peak groundwater pumping, and once following the irrigation season. The ordinance also requires water quality monitoring at least once a year during peak groundwater use using a network of wells that adequately represent groundwater quality conditions throughout the county and that provide a suitable amount of information to demonstrate compliance with the BMO. The land subsidence monitoring network would consist of selected benchmarks throughout the county that are surveyed at least every five years. In heavy groundwater use areas, extensometers may be required to provide continuous subsidence monitoring (Glenn County Board of Supervisors 1999).

Glenn County has developed a set of groundwater level BMOs in 17 subareas within the county. These BMOs are based on local input and available monitoring data. The county is acquiring and analyzing the monitoring data to be used in developing the water quality and land subsidence BMOs (Glenn County Board of Supervisors 2001).

In addition to the local management efforts described above, the EWA Project Agencies would not purchase water from a district unless the district has successfully complied with the groundwater mitigation measures. Therefore, in order for the transfers discussed above to occur, Glenn Colusa ID and RD 108 should implement the well review, monitoring, and mitigation measures outlined in the groundwater mitigation measures. *Consequently, EWA groundwater substitution transfers conducted in the Colusa groundwater subbasin could have potentially significant effects on groundwater levels, groundwater quality, surface water, and land subsidence. However, the groundwater transfers will be conducted in accordance with local management requirements and EWA groundwater mitigation measures (as discussed in Section 6.2.7 that will reduce these impacts to less than significant.*

East Butte and West Butte Groundwater Subbasins Groundwater Substitution

EWA acquisition of Feather River Contractor water in the East Butte and West Butte groundwater subbasins via groundwater substitution could affect groundwater hydrology. The potential effects could be decline in groundwater levels, interaction with surface water, land subsidence, and water quality impacts. EWA groundwater substitution would be concentrated in the Joint Water Districts and Western Canal WD.

Groundwater Levels*:* Groundwater substitution could result in temporary declines of groundwater levels. Figure 6-23 shows groundwater level fluctuations in wells in the West and East Butte subbasins. Historically, groundwater levels have remained relatively stable, from 1950 to present, with the exception of several localized areas. Declines of 10-15 feet in groundwater levels (since the 1950s) have been recorded in portions of the West Butte Subbasin, and isolated areas of groundwater depression resulting from year-round pumping of groundwater for municipal use exist near the City of Chico. Groundwater levels declined in other areas in response to the 1976-1977 and 1987–1994 droughts, but have since recovered (DWR 2002 and CDM 2001). Because of the aquifer's relatively short recovery period, an EWA asset acquisition via groundwater substitution would likely have a minimal effect on long-term groundwater level trends.

Groundwater levels fluctuate seasonally. The basin generally recharges in the winter and groundwater elevation depressions occur during the summer in the vicinities of Chico, Durham, and Honcut. Increased groundwater use within the northern portion of the East Butte subbasin has resulted in greater seasonal water table fluctuations in the northern portion than in the southern portion of the basin, as shown in Table 6-11 (DWR 2002).

Seasonal fluctuations recorded from wells in the north of the East Butte subbasin range from 4 feet in normal years to 10 feet during dry years. Fluctuations in the southern portion of the East Butte subbasin are approximately 4 feet during normal years and 10 feet during drought years. Average fluctuations in the West Butte Sub-basin are 15 to 25 feet during the normal years and about 30 feet during drought periods (DWR 2002).

Groundwater substitution under the Flexible Purchase Alternative could result in temporary drawdown that exceeds historical seasonal fluctuations. Table 6-11 compares the estimated potential drawdown that could result by a single year EWA-related groundwater transfer with historical fluctuations. Figure 6-23 shows the areas for which the regional declines are calculated. Groundwater may be extracted throughout the districts; consequently, this analysis used the entire area within the districts' boundaries to estimate drawdown.

<table>
<tr><th colspan="4">Table 6-11
Flexible Alternative Estimate of the Groundwater Drawdown for the Butte Subbasins</th></tr>
<tr><th></th><th>West Butte Subbasin</th><th colspan="2">East Butte Subbasin</th></tr>
<tr><td>EWA Acquisition Range</td><td>Western Canal – 10-35 TAF[1]</td><td colspan="2">Joint Water Districts – 20-60 TAF[2]
Western Canal WD – 10-35 TAF[1]</td></tr>
<tr><td>Estimated Regional Drawdown based on Range of Possible One-Year EWA Asset Acquisition</td><td>Western Canal WD – 3 to 10 feet</td><td colspan="2">Joint Water Districts – 3 to 8 feet
Western Canal WD – 3 to 10 feet</td></tr>
<tr><td>Normal Year Fluctuations</td><td>15 - 25 feet (semi-confined, confined)</td><td><u>North</u>
15 feet (composite wells[3])</td><td><u>South</u>
4 feet (composite wells)
4 feet (confined and semi-confined)</td></tr>
<tr><td>Drought Year Fluctuations</td><td>Up to 30 feet (semi-confined, confined)</td><td><u>North</u>
30 -40 feet (composite wells[1])</td><td><u>South</u>
10 feet (composite wells)
5 feet (confined and semi-confined)</td></tr>
</table>

Source of the normal and drought-year fluctuations: DWR 2002

[1] This acquisition range applies to the entire Western Canal WD, both in the West and East Butte subbasin.

[2] This estimate assumes that 75 percent of the acquisition range of 20-60 TAF, is allotted to the three of the Joint Water Districts, Biggs-West Gridley, Richvale, and Butte WD, in the East Butte subbasin. The remaining 25 percent is allotted to Sutter Extension WD in the Sutter subbasin. This partitioning was based on the density of potential pumping wells in each subbasin.

[3] Composite wells represent groundwater fluctuations that combine confined and unconfined portions of an aquifer

As shown in Table 6-11 , the potential regional groundwater level declines resulting from an EWA-related transfer could cause an additional 3 to 10-foot decline in the West Butte subbasin. This would not be a substantial decline when compared with the normal year fluctuations. In the East Butte subbasin, estimates indicate a potential 3- to 10-foot decline in Western Canal WD - declines similar to groundwater fluctuations observed during drought years. The service areas of the Joint Water Districts could experience regional declines of 3 to 8 feet, which could exceed normal year fluctuations by 4 feet in the southern portion of the East Butte subbasin. The potential for adverse drawdown effects would increase as the amount of extracted water increased. The potential for adverse effects would be higher still during dry years, when baseline fluctuations are already large and groundwater levels may be low.

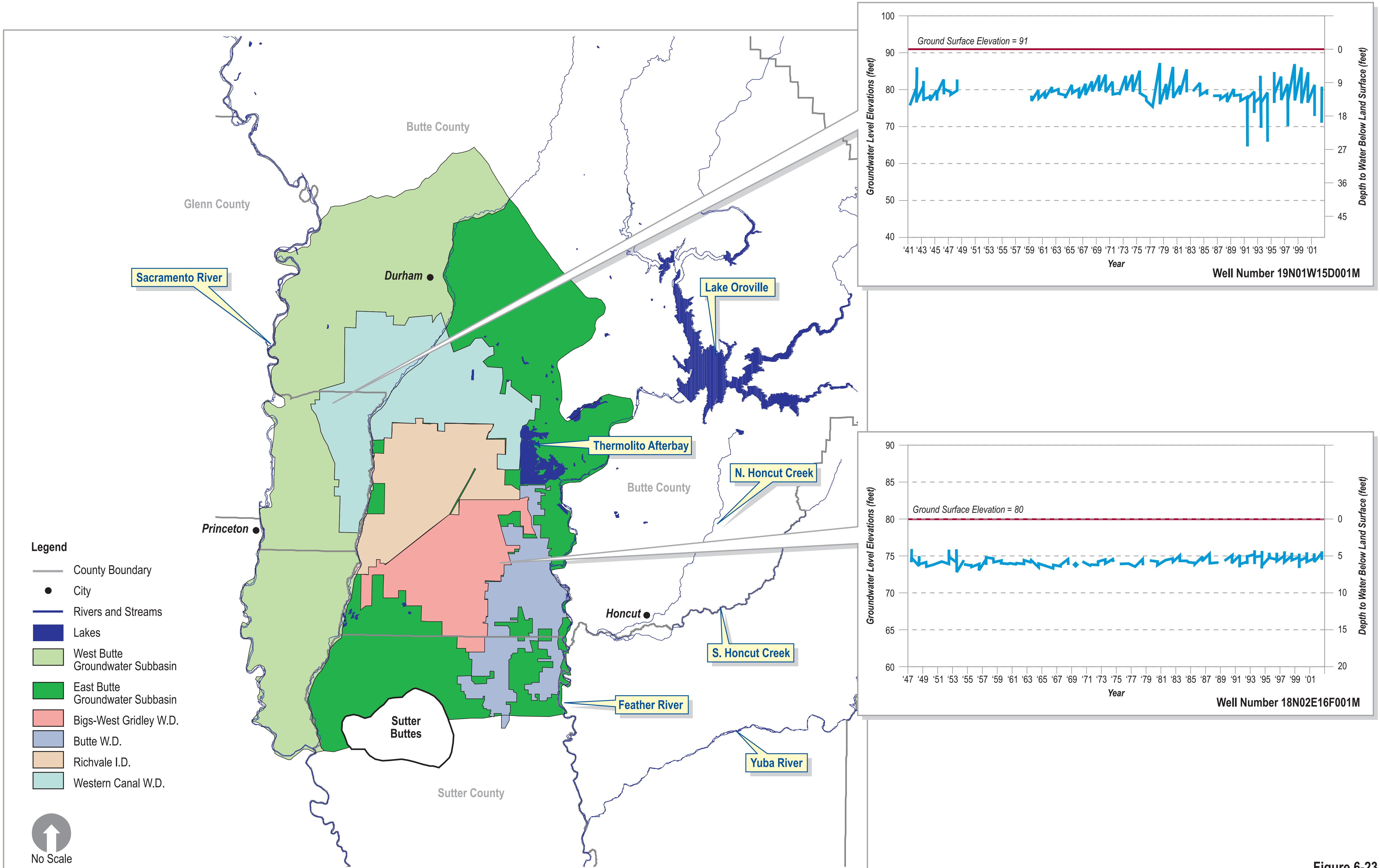


Figure 6-23
Groundwater Levels and Potential Sellers in the Butte Subbasins

Although there are exceptions,[14] the Joint Water Districts members and Western Canal WD rely primarily on surface water diverted from the Feather River. During normal years, groundwater transfers would be less likely to affect wells throughout the majority of the districts because local users rely extensively on surface water. During dry years, however, DWR has the option to reduce supplies to the Joint Water Districts .[15] Table 6-12 shows the number of wells within each district and the average depth of wells. Wells within the potential sellers' districts are relatively shallow. During dry years, groundwater may be an important supplement to surface water in some areas, and additional declines caused by groundwater substitution transfers would be more likely to result in adverse effects.

Table 6-12
Well Information for the Butte Groundwater Subbasins

Type of Well	***Number of Wells/Average Depth in feet***			
	Richvale	**Biggs-West Gridley**	**Butte WD**	**Western Canal WD**
Domestic	87 wells Average 114 ft	246 wells Average 92 ft	571 wells Average 83 ft	47 wells Average 145 ft
Irrigation	72 wells Average 303 ft	92 wells Average 221 ft	183 wells Average 165 ft	112 wells Average 470 ft
Municipal	0 wells	4 well Average 228 ft	8 wells Average 228 ft	0 wells
Other	21 wells	33 wells	115 wells	0 wells

Source: DWR Well Completion Reports (CDM 2001)

Increased groundwater pumping could also cause localized declines of groundwater levels, or cones of depression, near pumping wells. These declines are likely to be larger than those indicated in Table 6-11, possibly causing effects to wells within the cone of depression.

DWR monitors groundwater levels semi-annually in 32 and 43 wells in the West and East Butte subbasins, respectively. EWA groundwater substitution transfers could result in groundwater declines in excess of seasonal variation and these effects could be potentially significant. To reduce these effects, in addition to these monitoring activities, the groundwater mitigation measures specify that sellers establish monitoring programs for the EWA groundwater substitution transfer. The programs would monitor groundwater level fluctuations within the local pumping area and if effects were to occur, the districts within this area would implement appropriate

---

14 Such an exception is a portion of the Richvale ID service area, just west of Biggs and adjacent to the Butte Creek and Cherokee Canal. This area does not receive SWP allocation, but relies on groundwater and drainage water.

15 The Joint Water Districts administers 630,000 acre-feet of Feather River water to its member agencies including: Biggs-West Gridley WD, Butte WD, Richvale ID, and Sutter Extension ID. The Board controls, maintains, and operates the joint water distribution facilities for each district but does not own any production wells.

mitigation measures. These measures would reduce effects to less than significant levels.

Past Groundwater Transfers: Western Canal WD participated in the State Drought Water Bank transfers in 1991, 1992, and in 1994 (Table 6-13). Western Canal WD did not experience effects in either 1991 or 1992. However, in 1994, a number of independent pumpers north and east of Western Canal WD reported effects as a result of the 1994 Water Bank Transfers. Consequently, Western Canal WD experienced a temporary cessation in pumping at several wells, and some pumps stopped pumping permanently. This effect may have been partially attributable to the already low groundwater levels as a result of the 1991 and 1992 droughts, including an exceptionally dry 1992 spring, which resulted in an early irrigation season. Furthermore, a large number of the affected wells were shallow, pumping volumes for the State Drought Water Bank were not regulated, and the groundwater system was not well understood. In response to these effects, DWR, Butte County, and Western Canal WD increased monitoring activities and Butte County passed a groundwater protection ordinance.

Table 6-13
Past Groundwater Transfers in the Butte Subbasins

District	*Joint Water Districts*	*Western Canal WD*
1991 State Drought Water Bank	60,000	40,000
1992 State Drought Water Bank		49,600
SAFCA Transfer[1]	60,000	
1994 State Drought Water Bank		82,400

[1] Groundwater substitution transfers to SAFCA in the mid-1990s, compensating CVP for flood protection operations in Folsom Reservoir.

As shown in Table 2-5 in Chapter 2, the Joint Water Districts and Western Canal WD could transfer between 20-60 and 10-35 TAF, respectively, to the EWA Project Agencies. These acquisition ranges are within the range of transfers that have been conducted in the past.

Interaction with Surface Water: Pumping close to the Feather River along the eastern border of the East Butte subbasin and close to its tributaries could reduce channel flows. This could adversely affect the riparian and aquatic habitats and the downstream water users. Furthermore, groundwater is forced to the surface near the Sutter Buttes, resulting in wetland habitat along the west side of the Sutter Buttes (CDM 2001). Wetlands are also present in other areas throughout the Butte subbasins, and pumping activities could drain or interrupt the wetlands' water supply, thus adversely affecting these habitats.

Groundwater pumping for EWA groundwater substitution transfers could reduce flows in nearby surface water bodies and these effects could be potentially significant. To reduce these effects, the groundwater mitigation measures require evaluation of measures to avoid and minimize all such potential effects prior to an EWA-related transfer. Through the Well Review process identified in the groundwater mitigation measures, the purchasing agency would review the location and screened interval of the proposed production wells. If there were insufficient data to show that pumping would not result in adverse effects, production wells within 2 miles of a surface water body could be required to meet well depth criteria. Furthermore, the Well Review may determine that pumping activities should be limited to a specified depth in some areas to avoid hydraulic interaction between pumping and overlying surface water systems. In addition to the well review, the groundwater mitigation measures provide guidance for the establishment of a local monitoring and mitigation program, designed to identify and mitigate local impacts. These mitigation measures would reduce effects to less than significant levels.

Land Subsidence: Groundwater extraction for EWA asset acquisition would decrease groundwater levels, increasing the potential for local subsidence. Land subsidence has not been detected within the potential sellers' service districts; however, if groundwater levels were to be lowered substantially, there would be potential for subsidence. Nevertheless, no subsidence has been detected to date. If transfers under the Flexible Purchase Alternative do not cause groundwater levels to decline below historical levels, the potential for subsidence would be reduced.

Land subsidence monitoring within Butte County includes two extensometers that DWR recently installed. Figure 6-9 shows the location of these extensometers. These extensometers have not yet provided sufficient data to yield conclusive results (DWR Northern District 2002). Additional subsidence monitoring may be necessary, depending on the hydrology, expected groundwater use for an irrigation season, and the extraction the potential sellers in Butte subbasins plan to make under the Flexible Purchase Alternative. EWA groundwater substitution transfers could decrease groundwater levels that could cause potentially significant effects on land subsidence. To reduce these effects, the groundwater mitigation measures stipulate that all sellers have a monitoring and mitigation program in place to address potential land subsidence effects. The level of monitoring for land subsidence would be negotiated between the Review Team and the selling agency prior to the transfer. These mitigation measures would reduce effects to less than significant levels.

Groundwater Quality: Migration of reduced quality groundwater and agricultural use of reduced quality water would be the types of potential water quality effects associated with increased groundwater withdrawals providing EWA assets to the Project Agencies.

On-farm use of reduced quality water. Farmers that may participate in any EWA groundwater substitution transfers could experience changes in water quality as they switch from surface water to groundwater. However, groundwater quality is good for most agricultural and municipal purposes throughout the subbasin, and potential regional effects would be minimal.

Migration of Reduced Quality Groundwater: Although groundwater quality is sufficient for most agricultural and municipal purposes, elevated levels of manganese, iron, magnesium, TDS, calcium, nitrates, boron, chloride, bicarbonate, potassium, fluoride, and arsenic have been detected in localized areas throughout the Butte subbasins (DWR 2002 and DWR Northern District 2002). Inducing the movement or migration of reduced quality water into previously unaffected areas through groundwater pumping is not likely to be a concern unless groundwater levels and/or flow patterns are substantially altered for a long period of time. EWA groundwater extraction would be limited to short-term withdrawals during the irrigation season and EWA extraction near areas of reduced groundwater quality concern would be avoided through the groundwater mitigation measures Well Review process. (See Section 6.2.7.2 for more details.)

Additional assurances are provided by the groundwater mitigation measures that stipulate that all sellers have a monitoring and mitigation program that addresses potential adverse groundwater quality effects. If groundwater quality effects do occur, it would be the responsibility of the local selling agency to monitor and mitigate effects. The mitigation measures would therefore reduce any such impacts to less than significant levels.

Multi-Year Acquisition and Purchase During Dry Years: As discussed above, in many areas that may participate in the EWA Program, groundwater data indicates that during normal and wet years groundwater levels tend to recover to pre-irrigation levels. During dry years, however, groundwater use is typically increased and percolation from natural runoff is often lower than normal, causing groundwater levels to decline more than in normal and wet years. Furthermore, when dry years occur consecutively, groundwater levels are likely to decline throughout the dry period and then only recover after several normal or wet years. Historical water-level data illustrate this trend: groundwater levels tend to recover during normal and wet years, but the likelihood of full recovery decreases during dry years. Therefore, if EWA groundwater transfers were to occur for several consecutive years during a dry period, the transfer could contribute to the groundwater levels declining over a period of several years. Without sufficient wet season recovery, this decline could result in significant impacts.

The EWA's effects on groundwater levels during multi-year transfers or during dry years could be potentially significant. To reduce these effects, Butte County ordinances and the groundwater mitigation measures provide guidelines to evaluate groundwater levels prior to each EWA transfer. If groundwater levels prior to a proposed purchase were low relative to previous years, a pre-purchase evaluation would be performed to evaluate regional groundwater levels and potential drawdown. (See Section 6.2.7.2 for further details.) If the Review Team concluded that significant regional effects were probable, the EWA Project Agencies would not purchase water via groundwater substitution for the given hydrologic year, or they would request changes in the transfer mechanisms from the willing sellers. In contrast, if the Review Team concluded that the likelihood of regional effects would be minimal then the transfer could commence. The groundwater mitigation measures further stipulate that all sellers to the EWA Project Agencies should have a monitoring and mitigation program in place to address adverse effects should they occur. These mitigation measures would reduce effects to less than significant levels.

Local Groundwater Management and Monitoring: DWR currently monitors groundwater quality in four wells in the East Butte and eight wells in the West Butte subbasins. The Department of Health Services monitors water quality in 59 wells throughout the two subbasins, and Butte County monitors water quality in 15 wells throughout the county (DWR 2002). In addition to these monitoring activities, the groundwater mitigation measures specify that the potential selling districts' monitoring programs for an EWA groundwater substitution transfer would monitor groundwater quality within the local pumping area. If there were adverse effects on groundwater quality as a result of the transfer, all sellers in the Butte subbasins would be responsible for mitigation.

A variety of local management plans and ordinances may assist in minimizing effects associated with groundwater transfers. Biggs-West Gridley WD, Richvale ID, West Butte WD, and Western Canal WD have AB3030 Plans. Table 6-2 summarizes the components included in these plans. Butte, Glenn, and Colusa Counties have adopted county ordinances that are intended to aid in the protection of groundwater resources. Glenn and Colusa counties' ordinances are described in the Colusa subbasin section. Butte County's ordinances are described below. In addition to the established ordinances and groundwater management plans, a Butte Basin groundwater model has been developed to: 1) assess the groundwater resources of the Butte groundwater basin; 2) develop a quantitative understanding of the groundwater hydrology; and 3) evaluate potential regional hydrologic effects associated with proposed water management alternatives (Butte Basin Water Users Association 1996).

Chapter 33 Groundwater Conservation: This Butte County ordinance authorizes the establishment of a countywide groundwater-monitoring program to be implemented by the Butte County Water Commission in cooperation with the Technical Advisory Committee, the Butte Basin Water Users Association, DWR, and RWQCB. The ordinance requires completion of an annual report disclosing monitoring data from this program (four sampling rounds a year) in addition to data from other cities and agencies. The ordinance also requires a permit for all groundwater extraction that are to be transferred outside the county directly or indirectly via groundwater substitution (Butte County 1999).

Butte County Well-Spacing Ordinance: This ordinance requires the filing of a permit for construction, repair, deepening, or destruction of private or public water supply wells. It also sets restrictions on the spacing of wells based on capacity. This ordinance is intended to ensure that water obtained from wells within Butte County would be suitable for use and would not cause pollution or impairment of the quality of groundwater within the county (DWR Northern District 2002).

In addition to the local management efforts described above, the EWA Project Agencies would not purchase water from an agency unless the agency has successfully complied with the groundwater mitigation measures. Therefore, in order for the transfers discussed above to occur, Biggs-West Gridley WD, Richvale ID, Butte WD, and Western Canal WD should implement the well review, monitoring, and mitigation measures outlined in the groundwater mitigation measures. *Consequently, EWA groundwater substitution transfers in the East Butte and West Butte groundwater subbasins could have potentially significant effects on groundwater levels, groundwater quality, surface water, and land subsidence. However, the groundwater transfers will be conducted in accordance with local management requirements and EWA groundwater mitigation measures (as discussed in Section 6.2.7) that will reduce these impacts to less than significant.*

East Sutter Groundwater Subbasin

EWA acquisition of Feather River Contractor water in the East Sutter groundwater subbasin via groundwater substitution would affect groundwater hydrology. The potential effects would be decline in groundwater levels, interaction with surface water, land subsidence, and water quality impacts. EWA groundwater substitution would be concentrated in Sutter Extension ID and Garden Highway MWC.

Groundwater Levels*:* Groundwater substitution may result in temporary declines of groundwater levels in the Sutter subbasin. Figure 6-24 shows the East Sutter subbasin and groundwater level fluctuations in a DWR monitoring well. With the exception of moderate declines in the first half of the 1900s, groundwater levels are generally within 10 feet of the ground surface. Seasonally, levels decrease during the summer irrigation season and rebound following the winter rains. Stream percolation, deep percolation of rainwater, and applied irrigation water are the primary mechanisms for recharge of the aquifer (DWR 2002). Because of the aquifer's relatively short recovery period, an EWA-related transfer would likely have a minimal effect on long-term groundwater level trends.

Groundwater substitution under the Flexible Purchase Alternative could result in temporary drawdown that exceeds historical seasonal fluctuations. The potential drawdown as a result of an EWA-related groundwater transfer for Sutter Extension WD and Garden Highway MWC would be between 3 to 8 feet and 22 feet, respectively. These estimates are based on the assumption for Flexible Purchase Alternative acquisitions of 60 TAF and 3 TAF for Sutter Extension WD and Garden Highway MWC, respectively. This drawdown could adversely affect local wells; however, there are insufficient data to determine typical regional groundwater level fluctuations.

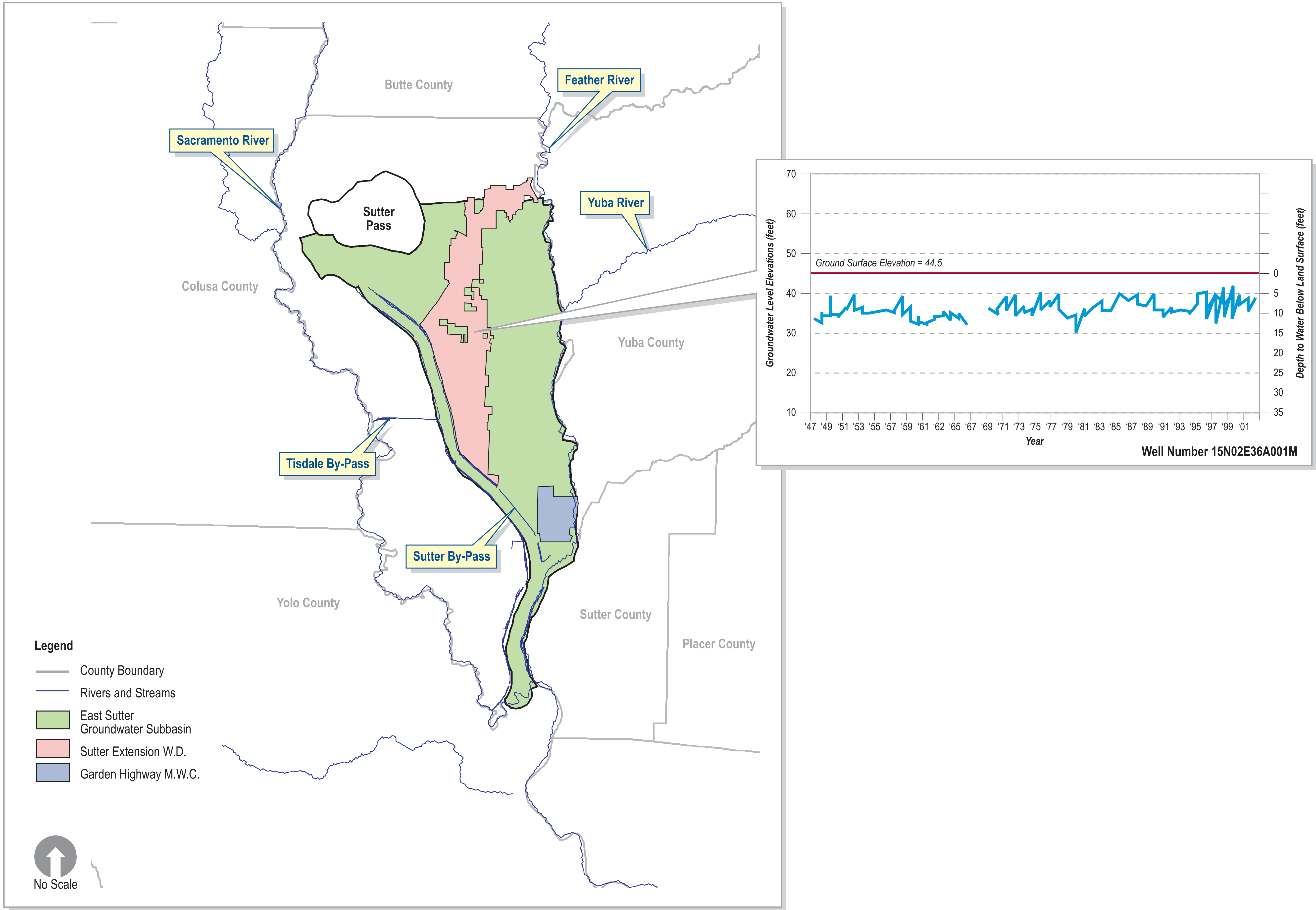


Figure 6-24
Groundwater Levels and Potential Sellers in the East Sutter Subbasin

Increased groundwater pumping could also cause localized declines of groundwater levels, or cones of depression, near pumping wells. These declines would likely be larger than the regional declines, possibly causing effects to wells within the cone of depression.

DWR and Sutter County WA monitor groundwater levels semi-annually in 22 wells (DWR 2002). EWA groundwater substitution transfers could result in groundwater declines in excess of seasonal variation and these effects could be potentially significant. To reduce these effects, in addition to this monitoring, the groundwater mitigation measures specify that Garden Highway MWC and Sutter Extension WD establish monitoring programs for EWA-related groundwater substitution transfers. The programs would monitor groundwater level fluctuations within the local pumping area and if effects were shown or reported to be occurring, the agencies within this area (Sutter Extension WD and Garden Highway MWC) would implement appropriate mitigation measures. These mitigation measures would reduce effects to less than significant levels.

Past Groundwater Transfers: Sutter Extension WD and Garden Highway MWC have not participated in any groundwater transfers outside their agencies.

Interaction with surface water: Pumping close to the Sacramento River along the eastern border of the subbasin could reduce channel flows. This could adversely affect the riparian and aquatic habitats and the downstream water users.

Groundwater pumping for EWA groundwater substitution transfers could reduce flows in nearby surface water bodies and these effects could be potentially significant. To reduce these effects, the groundwater mitigation measures require assessment of measures to avoid and minimize all potential effects prior to an EWA transfer. Through the Well Review process of the groundwater mitigation measures, the purchasing agency would review the location and screened interval of the proposed production wells. If there were insufficient data to show that pumping would not result in adverse effects, production wells within 2 miles of a surface water body could be required to meet well depth criteria. Furthermore, the Well Review may determine that pumping activities should be limited to a specified depth in some areas, in order to avoid hydraulic interaction between pumping and overlying surface water systems. In addition to the well review the groundwater mitigation measures provide guidance for the establishment of a local monitoring and mitigation program, designed to identify and mitigate local impacts. These mitigation measures would reduce effects to less than significant levels.

Land Subsidence: Groundwater extraction under the Flexible Purchase Alternative would decrease groundwater levels, increasing the potential for subsidence. As shown on Figure 6-9, the majority of the East Sutter subbasin is located in areas of possible historical subsidence, and subsidence has been detected in areas between Arbuckle and Davis, just southwest of the subbasin.

EWA groundwater substitution transfers could decrease groundwater levels that could cause potentially significant effects on land subsidence. To reduce these effects, the groundwater mitigation measures stipulate that all sellers to the EWA Project Agencies have a monitoring and mitigation program in place that addresses potential land subsidence effects. The level of monitoring for land subsidence would be negotiated between the Review Team and the selling agency prior to the transfer. These mitigation measures would reduce effects to less than significant levels.

Groundwater Quality: The migration of reduced quality groundwater, on-farm use of reduced quality water, and distribution of reduced quality water are the types of potential water quality effects associated with increased groundwater withdrawals related to EWA asset acquisition.

Migration of Reduced Quality Groundwater. Groundwater quality in the Sutter subbasin is variable; TDS concentrations range from 133 to 1,660 mg/L. TDS concentrations in the southern portion of the subbasin are typically higher. Other chemical elements and compounds detected in various wells throughout the subbasin have exceeded drinking water limits (DWR 2002). Inducing the movement or migration of reduced quality water into previously unaffected areas through groundwater pumping is not likely to be a concern unless groundwater levels and/or flow patterns are substantially altered for a long period of time. EWA groundwater extraction would be limited to short-term withdrawals during the irrigation season, and EWA extraction near areas of reduced groundwater quality concern would be avoided through the groundwater mitigation measures Well Review process. (See Section 6.2.7.2 for more details.) Additional assurances are provided by the groundwater mitigation measures that stipulate that all sellers have a monitoring and mitigation program that addresses potential adverse groundwater quality effects. If groundwater quality effects do occur, it would be the responsibility of the local selling agency to monitor and mitigate effects. The mitigation measures would therefore reduce any such impacts to less than significant levels.

Distribution of Reduced Quality Water: The Project Agencies would use the groundwater mitigation measures well review process to ensure that water placed in distribution systems due to EWA asset acquisition actions meets agricultural use requirements.

If adverse effects related to the degradation of groundwater quality from the transfer were to occur, the groundwater mitigation measures stipulate that all sellers have a monitoring and mitigation program in place that addresses potential adverse groundwater quality impacts. The mitigation measures would reduce any such impacts to less than significant levels.

Multi-Year Acquisition and Purchase During Dry Years: As discussed above, in many areas that may participate in the EWA Program, groundwater data indicate that during normal and wet years groundwater levels tend to recover to pre-irrigation levels. During dry years, however, groundwater use is typically increased and percolation from natural runoff is often lower than normal, and groundwater levels would decline more than in normal and wet years. Furthermore, when dry years occur consecutively, groundwater levels would likely to decline throughout the dry period and then only recover after several normal or wet years. Historical water-level data illustrates this trend: groundwater levels tend to recover during normal and wet years, but the likelihood of full recovery decreases during dry years. Therefore, if EWA groundwater transfers were to occur for several consecutive years during a dry period, the transfer could contribute to the groundwater levels declining over a period of several years. Without sufficient wet season recovery, this decline could result in significant impacts.

The EWA's effects on groundwater levels during multi-year transfers or during dry years could be potentially significant. To reduce these effects, the groundwater mitigation measures provide guidelines to evaluate groundwater levels prior to each EWA transfer. If groundwater levels prior to a proposed purchase were low relative to previous years, a pre-purchase evaluation would be performed to evaluate regional groundwater levels and potential drawdown. (See Section 6.2.7.2 for further details.) If the Review Team concluded that significant regional effects were probable, the EWA Project Agencies would not purchase water via groundwater substitution for the given hydrologic year, or they would request changes in the transfer mechanisms from the willing sellers. In contrast, if the Review Team concluded that the likelihood of regional effects would be minimal then the transfer could commence. The groundwater mitigation measures further stipulate that all sellers to the EWA Project Agencies should will have a monitoring and mitigation program in place to address adverse effects should they occur. These mitigation measures would reduce effects to less than significant levels.

Local Groundwater Monitoring and Management: DWR currently monitors groundwater quality in 27 wells throughout the subbasin. In addition, the Department of Health Services (including cooperators) monitors water quality in 49 wells (DWR 2002). During the well review process, the Project Agencies would review this and any additional monitoring criteria related to an EWA-related groundwater substitution transfer. If there were to be adverse effects related to the degradation of groundwater quality as a result of the transfer, the Garden Highway MWC and/or Sutter Extension WD would be responsible for mitigation.

Sutter Extension WD has an AB3030 Plan that could help minimize effects associated with groundwater transfers. Table 6-2 summarizes the components included in this plan. Sutter County wrote a county ordinance regarding groundwater, but it was not adopted. Sutter Extension WD has had discussions with neighboring water agencies about developing a countywide plan.

In addition to the local management efforts described above, the EWA Project Agencies would not purchase water from an agency unless the agency has successfully complied with the groundwater mitigation measures. Therefore, in order for the transfers discussed above to occur, Sutter Extension WD and Garden Highway MWC should implement the well review, monitoring, and mitigation measures outlined in the groundwater mitigation measures. *Consequently, EWA groundwater substitution transfers in the East Sutter groundwater subbasin could have potentially significant effects on groundwater levels, groundwater quality, surface water, and land subsidence. However, the groundwater transfers will be conducted in accordance with local management requirements and EWA groundwater mitigation measures (as discussed in Section 6.2.7) that will reduce these impacts to less than significant*.

North Yuba and South Yuba Groundwater Subbasins

EWA acquisition of water from Yuba County Water Agency by groundwater substitution in the North Yuba and South Yuba groundwater subbasins could affect groundwater hydrology. The potential effects would be decline in groundwater levels, interaction with surface water, land subsidence, and water quality impacts. Groundwater substitution would be concentrated in the Yuba County Water Agency (WA), member agencies of Browns Valley ID, Brophy WD, Ramirez WD, Hallwood Irrigation Company, South Yuba WD, Dry Creek MWC, and Cordua ID.

Groundwater Levels*:* Groundwater substitution may result in temporary declines in groundwater levels. Historical groundwater levels are different for the North Yuba subbasin and the South Yuba subbasin (Figure 6-25). Groundwater levels in the North Yuba subbasin generally declined prior to the mid-1960's, were relatively stable until about 1980, and have subsequently recovered to near historic high levels. Imposed on these general trends are single year declines that have occurred in dry years with rapid recovery during the following winter season. The South Yuba subbasin experienced long-term declines in water levels, indicative of overdraft, through the early 1980's. Subsequent to the development of the Yuba River Operating Program, deliveries of surface water began with the completion of the initial phase of the South Yuba Canal in 1983. Extension of the canal continues to this day with increasing areas of the South Yuba subbasin receiving surface water with a concomitant reduction in groundwater use. Groundwater levels in the South Yuba subbasin have risen as much as 100 feet in some areas. These water level rises coupled with the experience gained from recent water transfers indicated that significant unmitigated effects of a transfer to EWA would not alter long-term water level trends.

Groundwater substitution under the Flexible Purchase Alternative could, however, result in temporary drawdown that exceeds historical seasonal fluctuations. Estimates of an upper bound for regional water level declines associated with an EWA groundwater transfer could be up to 19 feet for both the North Yuba and South Yuba subbasins. However, the actual water level declines would generally be less than this amount. For example, Grinnell, 2002, indicated regional declines associated with a 65,000 acre-foot transfer from the North Yuba subbasin were on the order of 10 feet. Figure 6-25 shows the areas for which these regional declines were calculated**.** These areas were selected based on the use of wells for previous transfers to the EWA Project Agencies in 2001 and 2002. The estimate assumes that the north and south subbasins would each pump half of the total 85 TAF acquisition amount.

Extraction from the South Yuba subbasin would be less likely to effect third parties than extraction in the North Yuba subbasin because the potential declines would be within the range experienced during recent water transfers.

Increased groundwater pumping could cause localized declines of groundwater levels, or the development of cones of depression near pumping wells. In order to address these potential local declines, DWR and Yuba County WA implemented a cooperative monitoring program during Yuba County WA's groundwater substitution transfers to the EWA Project Agencies in 2001 and 2002. Monitoring is useful in identifying any effects that could occur as a result of pumping for an EWA transfer. EWA groundwater substitution transfers could result in groundwater declines in excess of seasonal variation and these effects on groundwater levels could be potentially significant. To reduce these effects, in addition to the monitoring activities discussed above, the groundwater mitigation measures further specify that Yuba County WA would be required to establish monitoring programs for EWA-related transfers. These programs would monitor groundwater level fluctuations within the local pumping area and if significant effects were to occur, Yuba County WA and/or its member agencies would be responsible for mitigation. Therefore, the mitigation measures would reduce effects to less than significant levels.

Past Groundwater Transfers: Table 6-14 summarizes past transfers conducted by Yuba County WA member agencies. Following the 1991 State Drought Water Bank transfer, groundwater levels in the North Yuba subbasin did not fully recover to pre-transfer levels by the following spring, yet subsequently did so (Fielden 2003). During the 2001 Dry Year Purchase Agreement (DYPA) groundwater substitution transfer adverse effects to groundwater levels were experienced along the eastern edge of the North Yuba subbasin. Several domestic wells on a hillside in the Las Quintas residential development experienced unsatisfactory water level declines. These wells were relatively shallow and were near several production wells that were pumping for the DYPA groundwater substitution transfer. Within several days of the incident, Cordua ID had addressed the problem by deepening the affected wells (Grinnel 2002).

In 2002, the EWA groundwater substitution transfer posed the potential of similar effects and following the transfer period, one well was affected. In response, the affected well was deepened and Cordua ID implemented an ongoing stakeholder interaction process that includes routine meetings and surveys of the individual domestic wells within the local area.

Table 6-14 ***Yuba County WA Past Groundwater Transfers (acre-feet)***							
Water Agency	***Browns Valley ID***	***Brophy WD***	***Ramirez WD***	***Hallwood ID***	***South Yuba WD***	***Dry Creek MWC***	***Cordua ID***
1991 State Drought Water Bank	2,700	36,000	13,300	6,500	17,300		6,500
1992 State Drought Water Bank	4,800	-	-	-	-	-	-
SAFCA Transfer[1]	3,681	-	-	-	-	-	-
1994 State Drought Water Bank	3,800	-	12,700	-	-	-	9,600
2001 Dry Year Purchase Agreement[3]	8,000[2]	-	17,000	12,000	9,000	9,100	-
2001 EWA	3,300		17,000	12,000	10,000	9,200	14,000
2002 EWA	5,217	10,901	8,786	7,381	8,193	5,417	9,363

[1]Groundwater substitution transfer that occurred in the mid-1990s to SAFCA.
[2] May include some reservoir release from Collins Reservoir.
[3] Contract Amount

As shown in Table 2-5 in Chapter 2, Yuba County WA could transfer 85,000 acre-feet via groundwater substitution under the Flexible Purchase Alternative. This amount exceeds the total amounts of 54,400 and 55,258 acre-feet transferred to the EWA Program in 2001 and 2002, respectively, yet is close to the amount transferred to the 1991 State Drought Water Bank (82,300 acre-feet). As discussed above, Yuba County WA has experienced and mitigated impacts resulting from previous transfers and has developed a monitoring program for prior EWA-related transfers.

As stipulated by the groundwater mitigation measures, a similar process for responding to alleged effects resulting from the water transfers would occur in the future.

Interaction with Surface Water: River flows could be reduced through pumping close to the Bear River to the south, or the Yuba River that flows through the subbasins. The Feather River borders the area on the west but pumping in support of water transfers does not occur near the river. Pumping could adversely affect the riparian and aquatic habitats and downstream water users. However, effects to riparian and aquatic habitats along the Feather and Yuba Rivers would be unlikely. Large flows would be maintained in these rivers that would continue to support aquatic and riparian resources at levels that would exist in the absence of a transfer to EWA. The portion

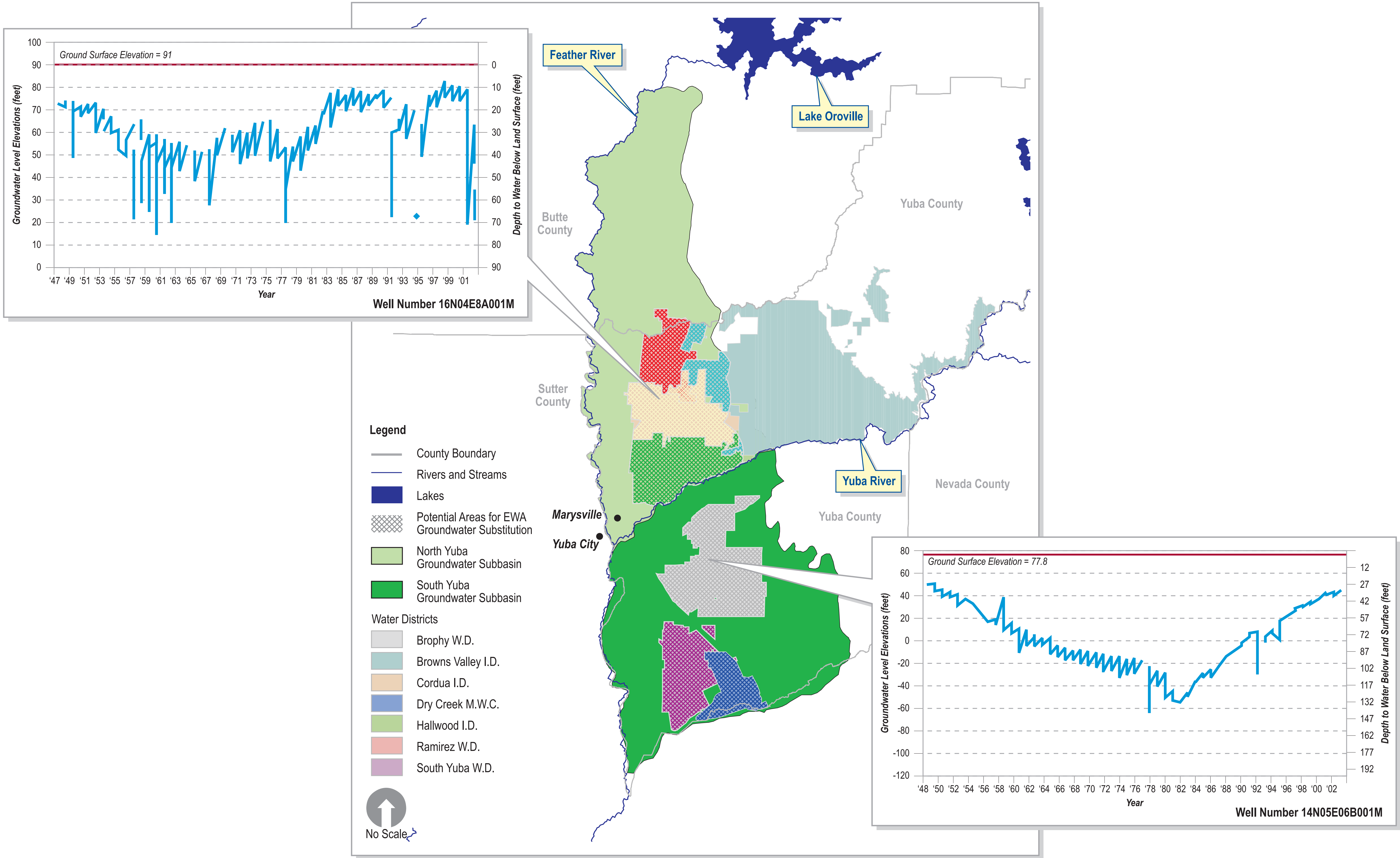


Figure 6-25
Groundwater Levels and Potential Sellers in the Yuba Subbasins

of the Bear River that would most likely be affected by transfers has only limited connection with adjacent groundwater that would be pumped. Limited monitoring suggests that little additional loss from the river occurs in response to transfer pumping. Furthermore, there are wetlands, primarily irrigated rice culture, throughout the area and pumping activities reduce groundwater available as part of the wetlands' water supply. However, the amount of water applied for irrigation and the resulting return flows would be largely unchanged as a result of transfers to the EWA and would continue to support wetlands.

Groundwater pumping for EWA groundwater substitution transfers could reduce flows in nearby surface water bodies and these effects could be potentially significant. To reduce these effects the groundwater mitigation measures require assessment of measures to avoid and minimize any significant potential effects of an EWA transfer. Through the Well Review process of the groundwater mitigation measures, the purchasing agency would review the location and screened interval of the proposed production wells. If data were insufficient to show that pumping would not result in adverse effects, production wells within 2 miles of a surface water body could be required to meet well depth criteria. Furthermore, the Well Review may determine that pumping activities should be limited to a specified depth in some areas, in order to avoid hydraulic interaction between pumping and overlying surface water systems. In addition to the well review , the groundwater mitigation measures provide guidance for the establishment of a local monitoring and mitigation program designed to identify and mitigate local impacts. These mitigation measures would reduce effects to less than significant levels.

Land Subsidence*:* Groundwater extraction for obtaining EWA assets would decrease groundwater levels, increasing the potential for local subsidence. Land subsidence has not been detected within the Yuba County WA member service agencies. The South Yuba subbasin has experienced substantial groundwater declines, and no subsidence has been detected in that subbasin. Because the North Yuba subbasin is geologically similar to the South Yuba subbasin, and the South Yuba basin has not experienced subsidence as a result of pumping, the potential for subsidence in the North Yuba subbasin is considered low. However, EWA groundwater substitution transfers could decrease groundwater levels that could cause potentially significant effects on land subsidence. To reduce these effects, the groundwater mitigation measures stipulate that all sellers have a monitoring and mitigation program that would address potential land subsidence effects. Considering the lack of subsidence demonstrated in the South Yuba subbasins, and the geologic similarity of the north and south subbasins, the level of monitoring needed to monitor land subsidence may be negotiated between the Review Team and the selling agency prior to the transfer. These mitigation measures would reduce effects to less than significant levels.

Groundwater Quality: Potential groundwater quality effects associated with increased groundwater withdrawals for EWA asset acquisition in the North Yuba and South Yuba subbasins include the migration of reduced quality water. Groundwater underlying Beale Air Force Base on the eastern boundary of the South Yuba subbasin is contaminated and being remediated (Grinnell 2002). In addition, high nitrate levels are present in the boundaries of Dry Creek MWC (Fielden 2003), and the upward migration of saline water from the deeper aquifers is of concern near Wheatland in the southeastern portion of the South Yuba subbasin. Although plans to supply surface water to this area are in the preliminary planning phase, this area currently relies on groundwater, which may cause the upward migration of saline water (Grinnell 2002 and Aikens 2003).

With the exception of these areas, groundwater is of good quality with a median TDS concentration of 277 mg/L and 224 mg/L for the North and South Yuba subbasins, respectively. Groundwater extraction associated with past transfers was a sufficient distance from these problem areas, thus avoiding any adverse groundwater quality effects. Assuming groundwater extraction projects would avoid these areas in the future no significant impacts related to the migration of reduced quality water would be likely; however, the mitigation measures would reduce any such impacts to less than significant levels. (See Section 6.2.7.2 for more details.)

The groundwater mitigation measures specify that if assets are acquired from the Yuba County WA, the agency should monitor groundwater quality within the local pumping area. If there were to be significant adverse effects from the degradation of groundwater quality associated with a transfer, the Yuba County Water Agency or its member agencies would be responsible for mitigating the adverse effects.

Multi-Year Acquisition and Purchase During Dry Years: As discussed above, during dry years, groundwater use increases and percolation from natural runoff is often lower than normal, causing groundwater levels to decline more than in normal and wet years. Furthermore, when dry years occur consecutively, groundwater levels would likely continue to decline until a wet period, when groundwater levels may recover. In addition, groundwater levels may not fully recover from a preceding year's transfer. Groundwater transfers over several consecutive years may increase the potential for adverse effects by causing net groundwater levels declines.

The EWA's effects on groundwater levels during multi-year transfers or during dry years could be potentially significant. To reduce these effects, local ordinances and the groundwater mitigation measures provide guidelines to evaluate groundwater levels prior to each EWA transfer. If groundwater levels prior to a proposed purchase were low relative to previous years, a pre-purchase evaluation would be performed to evaluate regional groundwater levels and potential drawdown. (See Section 6.2.7.2 for further details.) If the Review Team concluded that significant regional effects were probable, the EWA Project Agencies would not purchase water via groundwater substitution for the given hydrologic year, or they would request changes in the transfer mechanisms from the willing sellers. In contrast, if the Review Team concluded that the likelihood of regional effects would be minimal, then the transfer could commence. All sellers to the EWA Project Agencies should have a monitoring and mitigation program in place to address adverse effects should they occur. The mitigation measures would reduce effects to less than significant levels.

Local Groundwater Monitoring and Management: Yuba County WA maintains the largest water rights on the Yuba River, serving as a wholesaler of water to multiple water agencies, irrigation districts, and water companies. These include Brown's Valley ID, Brophy WD, Ramirez WD, Hallwood Irrigation Company, Dry Creek MWC, South Yuba WD, and Cordua ID.

Yuba County WA has regulatory authority regarding the use of groundwater resources within its boundaries; however, the Agency has chosen to exercise its authority by developing cooperative relationships with its member agencies to conjunctively manage the groundwater resource. Yuba County WA is currently developing an AB3030 Plan. This plan would incorporate all twelve elements outlined in AB3030. The plan would also include a description of Yuba County WA's current and planned activities, including: the ongoing development of a conjunctive use program, and the cooperative DWR and Yuba County WA monitoring plan. In addition to the Yuba County WA plan, South Yuba WD and Cordua ID have developed individual AB3030 plans. These two districts, in addition to the remaining Yuba County WA member agencies, would be included in the upcoming Yuba County WA AB3030 plan (Grinnell 2002).

Yuba County Water Agency has a number of water transfer policies that help guide agency operations. These policies specify that groundwater transfers should not result in unmitigated third party effects, or cause overdraft (Grinnell 2002). Brown's Valley ID also has a set of principles and policies addressing groundwater substitution transfers (Cotter 2002).

In addition to the local management efforts described above, the EWA Project Agencies would not purchase water from an agency unless the agency has successfully complied with the groundwater mitigation measures. Therefore, in order for the transfers discussed above to occur, Yuba County WA or Yuba County WA member agencies should implement the well review, monitoring, and mitigation measures outlined in the groundwater mitigation measures. *Consequently, EWA groundwater substitution transfers in the North Yuba and South Yuba groundwater subbasins could have potentially significant effects on groundwater levels, groundwater quality, surface water, and land subsidence. However, the groundwater transfers will be conducted in accordance with local management requirements and EWA groundwater mitigation measures (as discussed in Section 6.2.7) that will reduce these impacts to less than significant*.

North American (River) Groundwater Subbasin Groundwater Substitution

EWA acquisition of American or Sacramento River water in the North American groundwater subbasin via groundwater substitution would affect groundwater hydrology. The potential effects would be decline in groundwater levels, interaction with surface water, land subsidence, and water quality impacts. Groundwater substitution would most likely be concentrated in Natomas Central Mutual Water Company.

***Groundwater Levels**:* Groundwater substitution could result in temporary declines of groundwater levels. In contrast to the groundwater levels in much of the North American subbasin that have historically varied, historical groundwater levels underlying Natomas Central MWC boundaries have remained relatively stable. (See North American Groundwater Purchase in this section for more details on regional groundwater levels in the subbasin.) However, a cone of depression near McClellan Air Force Base, four miles east of the southeast corner of Natomas Central MWC, influences groundwater flow in the eastern portion of the service area. Groundwater levels are lowest in the eastern portion of the service area, near the pumping depression, and increase westward towards the Sacramento River. Groundwater level declines, resulting from the droughts in 1976-1977 and 1988-1992, have been followed by recovery for the majority of the service area, with the exception of some wells in the eastern portion of the service area following the 1988-1992 drought. Figure 6-26 shows Natomas Central MWC and groundwater levels from two wells in the eastern portion and western portion of the agency. The highest groundwater levels have been observed along the northern boundary of the Natomas Cross Canal. Because of the aquifer's relatively short recovery period, an EWA-related transfer would likely have a minimal effect on long-term groundwater level trends.

Groundwater substitution involving EWA asset acquisitions could result in temporary drawdown that exceeds historical seasonal fluctuations. Table 6-15 compares the historical fluctuations with the estimated potential drawdown caused by EWA-directed groundwater transfers. Figure 6-26 shows the areas for which the regional declines were estimated. These areas were selected based on the wells previously used for the 2001 Forbearance Agreement transfer.

As shown in Table 6-15, the potential groundwater level decline in Natomas Central MWC, assuming a single year acquisition amount of 15,000 acre-feet, could be 9 feet in addition to typical seasonal fluctuations. If the transfer occurred during a normal year, regional declines would most likely not exceed those typically observed in the semi-confined aquifers during drought years. The likelihood of adverse effects to wells would increase with the amount extracted for the EWA transfer and also would increase during dry years. Shallow domestic wells would be most susceptible to adverse effects. Fifty percent of the domestic wells are 150 feet deep or less (Table 6-16).

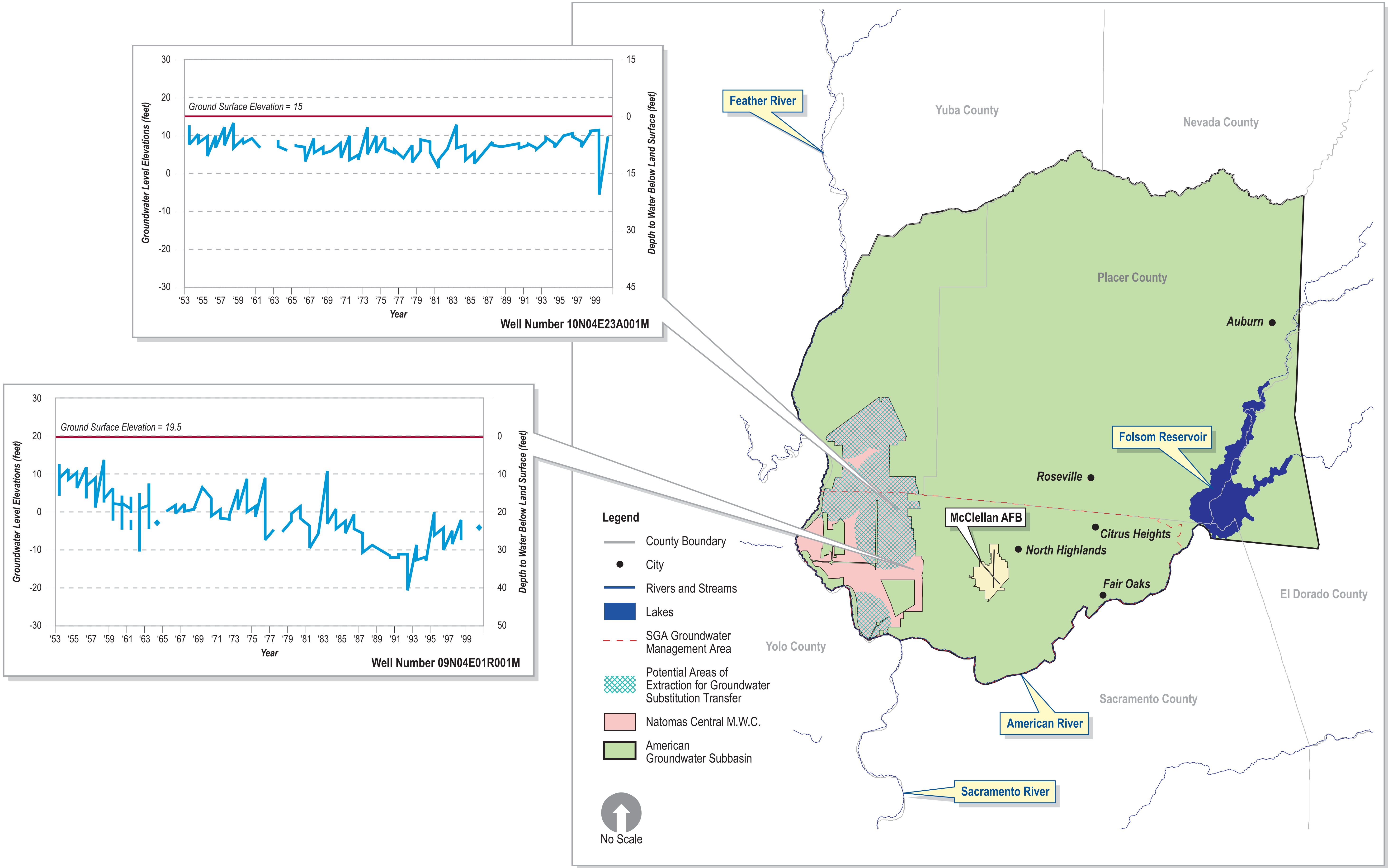


Figure 6-26
Groundwater Levels and Natomas Central M.W.C. in the North American Subbasin

Table 6-15 Flexible Purchase Alternative Estimate of Groundwater Drawdown in Natomas Central MWC	
EWA Acquisition Range	15,000
Estimated Regional Drawdown based on Range of Possible One-Year EWA Asset Acquisition	9 feet
Normal Year Fluctuations	2-6 feet (unconfined) Up to 10 feet (semi-confined)
Fluctuations between drought periods	Up to 10 feet (unconfined) Up to 25 feet (semi-confined)

Source for groundwater fluctuations: (DWR Northern District 2002)

Table 6-16
Natomas Central MWC Well Data

Well	Amount	Average Depth	Depth Distribution
Domestic	125	149	50% - 140 ft depth or less
			20% - 110 ft depth or less
			10% - 100 ft depth or less
Irrigation	94	313	50% - 280ft depth or less
			20 % - 180ft depth or less
			10% - 150 ft depth or less
Municipal	8	308	Not calculated
Industrial	8	378	Not calculated
Other	61	132	Not calculated

Source: Well Completion Reports filed with the DWR (DWR Northern District 2002)

Historically, Natomas Central MWC has relied on surface water diverted from the Sacramento River and consequently, has relatively limited groundwater development. The MWC has used groundwater as a supplement to surface supplies during dry years through the discretion of private landowners. It would be unlikely that EWA-related transfers in the Natomas Central MWC would result in substantial effects to existing wells.

Increased groundwater pumping could cause localized declines of groundwater levels, or cones of depression, near pumping wells. These declines could be larger than those indicated in Table 6-15, possibly causing effects to wells within the cone of depression.

Currently, DWR is monitoring groundwater levels in 19 wells throughout the agency (Luhdorff & Scalmanini 2002). EWA groundwater substitution transfers could result in groundwater declines in excess of seasonal variation and these effects on groundwater levels could be potentially significant. To reduce these effects, in addition to these monitoring activities, the groundwater mitigation measures specify that Natomas Central MWC establish a monitoring program for EWA-related groundwater substitution transfers. These programs would monitor groundwater level fluctuations within the local pumping area and if effects were shown or reported to be occurring, Natomas Central MWC would implement appropriate mitigation measures. These mitigation measures would reduce effects to less than significant levels.

Past Groundwater Transfers: The Natomas Central MWC has transferred water via groundwater substitution to Westlands WD under the 2001 Forbearance Agreement. The MWC's service area did not experience any significant impacts as a result of the 2001 transfers.

Interaction with Surface Water*:* Pumping near the Sacramento River, along the western border of the agency, could reduce channel flows and thus adversely affect riparian and aquatic habitats and downstream water users. Furthermore, pumping activities could drain or interrupt the water supply to wetlands in the area and adversely affect wetland habitats.

Groundwater pumping for EWA groundwater substitution transfers could reduce flows in nearby surface water bodies and these effects could be potentially significant. To reduce these effects, the groundwater mitigation measures involve assessment of measures to avoid and minimize all such potential effects prior to an EWA transfer. Through the Well Review process identified in the groundwater mitigation measures, the purchasing agency would review the location and screened interval of the proposed production wells. If date were insufficient to show that pumping would not result in adverse effects, production wells within 2 miles of a surface water body could be required to meet well depth criteria. Furthermore, the Well Review may determine that pumping activities should be limited to a specified depth in some areas, to avoid hydraulic interaction between pumping and overlying surface water systems. In addition to the well review, the groundwater mitigation measures provide guidance for the establishment of a local monitoring and mitigation program, designed to identify and mitigate local impacts. These mitigation measures would reduce effects to less than significant levels.

Land Subsidence*:* While land subsidence has not been detected within Natomas Central MWC service area, groundwater extraction for EWA asset acquisition could decrease groundwater levels, increasing the potential for local subsidence. Areas of historic subsidence are just west of the service area (Figure 6-9). If transfers under the Flexible Purchase Alternative do not cause the groundwater levels to decline below historical levels, the potential for subsidence would be minimized.

Land subsidence monitoring within the vicinity of the Natomas Central MWC includes one DWR extensometer on the Natomas Cross Canal. Monitoring could be necessary, depending on the hydrology, expected groundwater use for an irrigation season, and the volume of groundwater extracted under the Flexible Purchase Alternative.

EWA groundwater substitution transfers could decrease groundwater levels that could cause potentially significant effects on land subsidence. To reduce these effects, the groundwater mitigation measures stipulate that all sellers to the EWA Project Agencies have a monitoring and mitigation program to address potential land subsidence effects. The level of monitoring needed to monitor land subsidence may be negotiated between the Review Team and the selling agency prior to the transfer. These mitigation measures would reduce effects to less than significant levels.

Groundwater Quality: The migration of reduced quality groundwater and on-farm use of reduced quality water are two types of potential water quality effects associated with increased groundwater withdrawals.

The migration of reduced quality groundwater. Groundwater underlying McClellan Air Force Base east of the Natomas Central MWC is contaminated by organic solvents and is migrating southward, towards the City of Sacramento wells. Remedial measures currently in use include supplying some domestic well users with municipal sources, monitoring, installing physical surface barriers, and groundwater pump and treat systems. There is potential for contamination to migrate into Natomas Central MWC; however, groundwater levels would have to be substantially lowered for several years for this to occur (Luhdorff & Scalmanini 2002).

EWA groundwater substitution transfers could cause potentially significant effects on groundwater quality; however, transfers would be limited to short-term withdrawals during the irrigation season and would most likely not result in substantial groundwater declines. The Well Review stipulated in the groundwater mitigation measures provides further assurances that the potential for reduced groundwater quality migration would be evaluated prior to the transfer, further reducing the likelihood of adverse effects. The mitigation measures would therefore reduce effects to less than significant levels.

On-farm Use of Reduced Quality Water. Potential Natomas Central MWC farmers that may participate in the groundwater substitution transfers could experience changes in water quality as they switch from surface water to groundwater. Elevated levels of TDS, chloride, sodium, bicarbonate, boron, iron, manganese, and arsenic have been detected in the western portions of the agency, west of Highway 99, that could be harmful to some crops. Elevated levels of boron and iron have also been detected near the Sacramento International Airport (Luhdorff & Scalmanini 2002).

The groundwater mitigation measures specify that Natomas Central MWC be responsible for monitoring groundwater quality within the local pumping area and mitigating any adverse effects should they occur; therefore, the mitigation measures would reduce any impacts to less than significant levels.

Multi-Year Acquisition and Purchase During Dry Years: As discussed above, in many areas that may participate in the EWA Program, groundwater data indicate that during normal and wet years groundwater levels tend to recover to pre-irrigation levels. During dry years, however, groundwater use is typically increased, and percolation from natural runoff is often lower than normal, causing groundwater levels to decline more than during normal and wet years. Furthermore, when dry years occur consecutively, groundwater levels would likely to decline throughout the dry period and then only recover after several normal or wet years. Historical water level data illustrate this trend: groundwater levels tend to recover during normal and wet years, but the likelihood of full recovery decreases during dry years. Therefore, if EWA groundwater transfers were to occur for several consecutive years during a dry period, the transfer could contribute to the groundwater levels declining over a period of several years. Without sufficient wet season recovery, this decline could result in significant impacts.

The EWA's effect on groundwater levels during multi-year transfers or during dry years could be potentially significant. To reduce these effects, the groundwater mitigation measures provide guidelines to evaluate groundwater levels prior to each EWA transfer. If groundwater levels prior to a proposed purchase were low relative to previous years, a pre-purchase evaluation would be performed to evaluate regional groundwater levels and potential drawdown. (See Section 6.2.7.2 for further details.) If the Review Team concluded that significant regional effects would be probable, the EWA Project Agencies would not purchase water via groundwater substitution for the given hydrologic year, or they would request changes in the transfer mechanisms from the willing sellers. In contrast, if the Review Team concluded that the likelihood of regional effects would be minimal, then the transfer could commence. All sellers to the EWA Project Agencies should have a monitoring and mitigation program in place that would address adverse effects should they occur. These mitigation measures would reduce effects to less than significant levels.

Local Groundwater Management: Because Natomas Central MWC is a private entity, the agency cannot adopt a formal AB3030 Plan; however, Natomas Central MWC has developed a groundwater management plan (that contains many of the components specified in AB3030) to serve as an "effective equivalent." The overall goal of the plan is to expand the Agency's local groundwater use for agriculture and other users while continuing to use local surface water supplies. Additional goals of the plan are to:
1) continue groundwater development in accordance with the perennial yield,
2) implement conjunctive use that preserves surface water rights and supplies,
3) cooperate with local agencies to find a solution to alleviate the groundwater depression east of the service area, and 4) cooperate in implementing CALFED Regional Partnerships that address the beneficial use of surplus surface water supplies incorporating regional and local transfers. The plan prioritizes the AB3030 elements according to first and second priority (Luhdorff & Scalmanini Consulting Engineers 2002).

Natomas Central MWC is also a signatory of the Water Forum Agreement (WFA), accepting to "endorse and, where appropriate, participate in implementation of the Sacramento North Area Groundwater Management Authority to maintain a North

Area estimated average sustainable yield of 131,000 acre-feet (Water Forum 1999)." (See Local Groundwater Management in the North American Groundwater Purchase in this section for more details.) Natomas Central MWC and the Sacramento Groundwater Authority (SGA) are preparing a Memorandum of Understanding (MOU) regarding the cooperative management of water resources. Components of the management program include 1) development of a groundwater monitoring and data collection system; 2) development of economic incentives and disincentives to encourage, if necessary, the implementation of regional conjunctive use; 3) development of a regional, pilot groundwater banking and exchange/surface water transfer program; 4) coordination of groundwater quality protection; and 5) development of a comprehensive outreach and education program (Luhdorff & Scalmanini 2002).

In addition to the local management efforts described above, the EWA Project Agencies would not purchase water from an agency unless the agency has successfully complied with the groundwater mitigation measures. Therefore, Natomas Central MWC would have to implement the well review, monitoring, and mitigation measures outlined in the groundwater mitigation measures. *Consequently, EWA groundwater substitution transfers in the North American (River) groundwater subbasin could have potentially significant effects on groundwater levels, groundwater quality, surface water, and land subsidence. However, the groundwater transfers will be conducted in accordance with local management requirements and EWA groundwater mitigation measures (as discussed in Section 6.2.8) that will reduce these impacts to less than significant.*

North American (River) Groundwater Subbasin Groundwater Purchase

EWA acquisition of American River water in the North American groundwater subbasin via groundwater purchase would affect groundwater hydrology. The potential effects would be decline in groundwater levels, interaction with surface water, land subsidence, and water quality impacts. EWA groundwater transfers would most likely be managed by the Sacramento Groundwater Authority (SGA) and concentrated in the City of Sacramento, Fair Oaks Water District, and Citrus Heights Water District.

Groundwater Levels: EWA Project Agency groundwater purchase transfers could result in temporary declines of groundwater levels. Groundwater levels in Sacramento County were relatively stable at an elevation of 30 feet above msl in the 1930s. In the northern third of the subbasin, groundwater pumping resulted in groundwater level declines until the mid-1960s when the Camp Far Reservoir was completed in 1963, supplying surface water (Fielden 2003). In contrast, pumping in the southern portion of the subbasin has increased steadily since the 1970s, causing groundwater levels to generally decrease by about one and one-half feet per year. (This does not pertain to the portion of the subbasin underlying Natomas Central MWC. (See previous section on groundwater levels in Natomas Central MWC for further details.) The greatest declines have been observed in the vicinity of McClellan

Air Force Base (DWR 2002). Groundwater acquired under the Flexible Purchase Alternative would most likely be extracted from wells owned by the City of Sacramento, Fair Oaks WD, and Citrus Heights WD. Figure 6-27 shows representative hydrographs for wells in these areas.

The 131,000 acre-foot sustainable yield noted in the WFA applies to the Sacramento County portion of the North American Subbasin, which is managed by the SGA. As a result of the WFA, groundwater extraction in the SGA's management area are not to exceed the defined sustainable yield, which should maintain groundwater levels above –70 to –80 feet msl (EDAW and SWRI 1999). Any EWA-related groundwater extraction would also be subject to this limit and consequently, EWA transfers could not contribute to the exceedance of the sustainable yield.

Estimates of the potential regional drawdown that could be caused by an EWA groundwater transfer for areas in which groundwater purchases are expected to occur have been made. Figure 6-27 shows the areas for which the regional declines were calculated. These areas were selected based on wells used previously for the 2002 EWA Program transfer. (See discussion below.) This analysis assumes a proportional distribution of pumping according to the amounts transferred to the EWA Program in 2001. Sixty five percent of the potential EWA acquisition of 10,000 acre-feet was allocated to the Citrus Heights and Fair Oaks wells, and the remaining thirty five percent was allocated to the City of Sacramento wells. Declines of 2 and 4 ½ feet were estimated for the City of Sacramento wells and the Citrus Height/Fair Oaks wells, respectively. Adverse effects associated with these regional declines are minimal.

Increased groundwater pumping could also cause localized declines of groundwater levels, or cones of depression, surrounding the pumping wells. These declines could be larger than the regional declines discussed above, possibly causing local effects to wells within the cone of depression.

DWR currently monitors groundwater levels in 53 wells semi-annually and in 7 wells monthly throughout the North American subbasin. Sacramento County also monitors groundwater levels in 17 wells throughout the county (DWR 2002). EWA groundwater purchase transfers could result in groundwater declines in excess of seasonal variation and these effects on groundwater levels could be potentially significant. To reduce these effects, in addition to these monitoring activities, the groundwater mitigation measures specify that the SGA be responsible for establishing a monitoring program that would monitor groundwater level fluctuations within the local pumping area for an EWA transfer and if effects were shown or reported to be occurring, the SGA would implement appropriate mitigation measures. These mitigation measures would reduce effects to less than significant levels.

Past Groundwater Transfers: During the 2002 irrigation season, the SGA provided 7,143 acre-feet of groundwater to the EWA Program via groundwater purchase. This sale was a pilot operation with the option that it could be expanded in the future. The

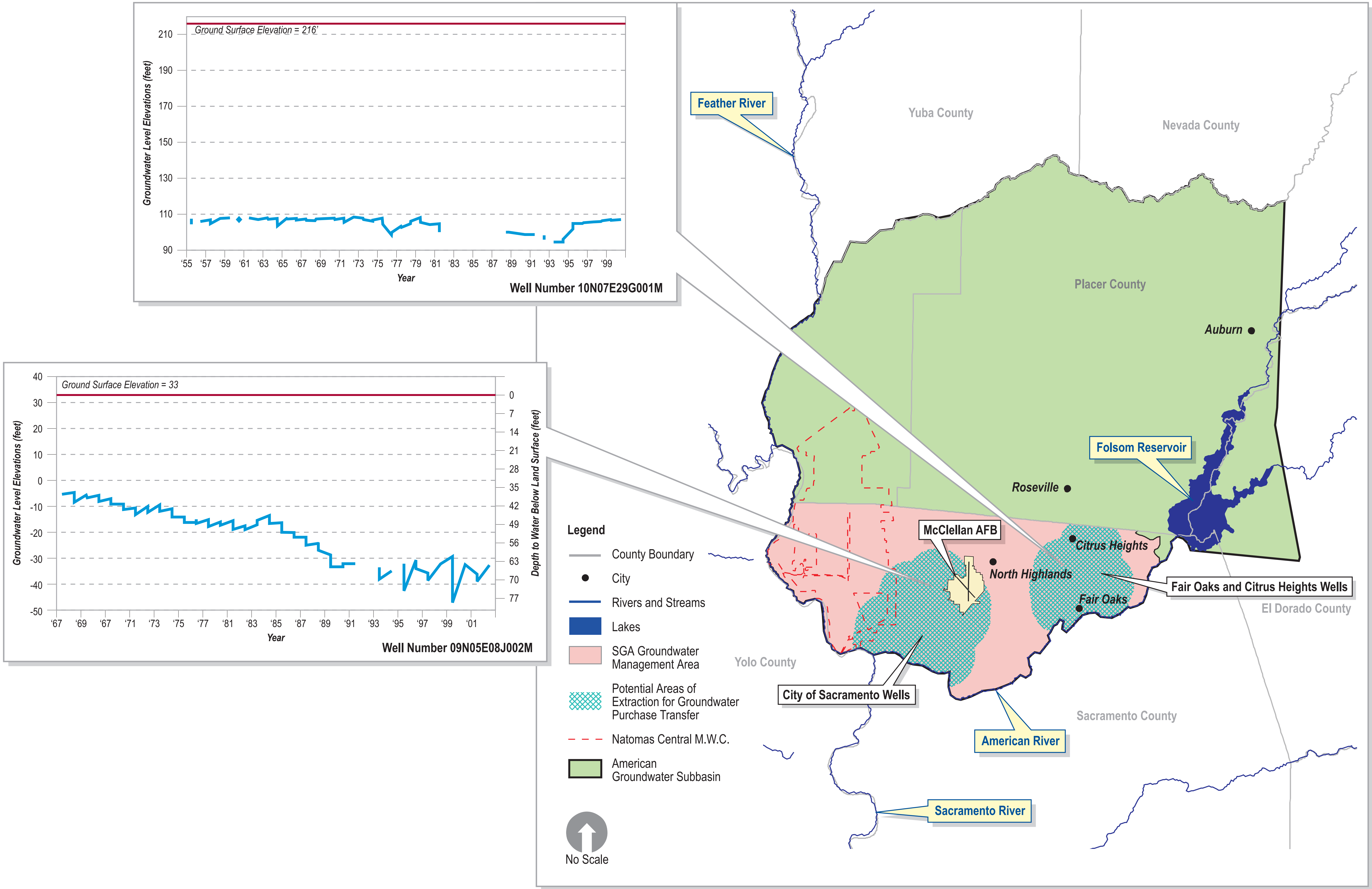


Figure 6-27
Groundwater Levels and Potential Sellers in the SGA Management Area

agencies involved with this transfer included SGA, Citrus Heights WD, Fair Oaks WD, Northridge WD, City of Sacramento, and San Juan WD. Citrus Heights and Fair Oaks agreed to use 4,646 acre-feet of groundwater in their service areas in-lieu of treated surface water from San Juan WD. This permitted San Juan WD to reduce its surface water diversion from Folsom Lake, allowing surplus water to be transferred to the EWA. Northridge WD accounted for the delivery of surface water in lieu of the extraction of groundwater by Citrus Heights WD and Fair Oaks WD, negating any effects to the groundwater basin underlying Sacramento County north of the American River. The City of Sacramento also agreed to use 2,497 acre-feet of groundwater in lieu of receiving surface water diversion from the American River. The 2,497 acre-foot of surface water remaining in the American River was transferred to the EWA Project Agencies. The City of Sacramento accounted for the delivery of 2,497 acre-feet of surface water from an alternative water source in lieu of extracting groundwater, thus negating any potential groundwater impacts.

Interaction with Surface Water: Pumping near the American River along the southern border of the North American subbasin and close to its tributaries could reduce channel flows and thus adversely affect riparian and aquatic habitats and downstream water users. Furthermore, pumping activities could drain or interrupt wetland habitats in the close vicinity of pumping.

Groundwater pumping for EWA groundwater purchase transfers could reduce flows in nearby surface water bodies and these effects could be potentially significant. To reduce these effects, the groundwater mitigation measures require assessment of measures to avoid and minimize all potential effects prior to an EWA transfer. Through the Well Review process of the groundwater mitigation measures, the purchasing agency would review the location and screened interval of the proposed production wells. Production wells within 2 miles of a surface water body would need to meet well depth criteria if data were insufficient to show that pumping would not result in adverse effects. Furthermore, the Well Review may determine that pumping activities should be limited to a specified depth in some areas, to avoid hydraulic interaction between pumping and overlying surface water systems.

In addition to the well review, the groundwater mitigation measures provide guidance for the establishment of a local monitoring and mitigation program designed to identify and mitigate local impacts. These mitigation measures would reduce effects to less than significant levels.

Land Subsidence: Groundwater extraction for the EWA asset acquisition could decrease groundwater levels, increasing the potential for local subsidence. Minor subsidence of up to 0.4 foot occurred in SGA's management area between 1912 and the 1960s (EDAW and SWRI 1999). These historical data, in addition to projected groundwater extraction, do not indicate the likelihood of any substantial subsidence from groundwater pumping in the future. As discussed under Local Groundwater Management below, the WFA's sustainable yield results in a stabilized groundwater level of approximately –83 feet msl with a range of –70 to –87 feet msl. As part of the WFA EIS/EIR, potential subsidence was evaluated assuming that groundwater level declines would not exceed levels stipulated by the WFA. The WFA used the Integrated Groundwater-Surface Water Model (IGSM) to model subsidence. The model indicated that an additional 0.35 foot of subsidence over several decades was possible, assuming the ratio of about 0.02 foot of subsidence per foot of groundwater level decline (EDAW and SWRI 1999). As long as transfers under the Flexible Purchase Alternative do not cause the groundwater to decline below the target groundwater level proposed by the WFA, substantial subsidence would not be expected.

Land subsidence monitoring within the vicinity of the SGA service area includes one DWR extensometer on the Natomas Cross Canal at the border of Natomas Central MWC. Additional monitoring may be necessary, depending on the hydrology, expected groundwater use, and the extraction SGA plans to pump.

EWA groundwater purchase transfers could decrease groundwater levels that could cause potentially significant effects on land subsidence. To reduce these effects the groundwater mitigation measures stipulate that all sellers to the EWA Project Agencies have a monitoring and mitigation program in place that would address potential land subsidence effects. The level of monitoring needed to monitor land subsidence may be negotiated between the Review Team and the selling agency prior to the transfer. These mitigation measures would reduce these effects to less than significant levels.

Groundwater Quality: Groundwater withdrawals under the Flexible Purchase Alternative could induce the migration of reduced quality groundwater into previously unaffected areas. Groundwater is generally of good quality; however, there are areas of concern. Reduced quality water at several well sites has caused the wells to be shut down. Elevated levels of TDS, chloride, sodium, bicarbonate, boron, fluoride, nitrate, iron manganese, and arsenic have been detected in localized areas. Contaminated sites in the area include an abandoned Pacific Gas and Electric (PG&E) site adjacent to the Sacramento River near Old Sacramento, the Union Pacific Railroad yards in downtown Sacramento and in the City of Roseville (EDAW and SWRI 1999), and a TCE plume in Fair Oaks WD. Contaminants underlying McClellan Air Force Base have migrated south, toward the City of Sacramento wells. Remedial measures implemented include supplying some domestic well users with municipal water sources, groundwater monitoring, installing physical surface barriers in one location, and extracting and treating groundwater (Luhdorff & Scalmanini 2002).

EWA groundwater substitution transfers could cause potentially significant effects on groundwater quality; however, inducing the movement or migration of reduced quality water into previously unaffected areas through groundwater pumping is not likely to be a concern unless groundwater levels and/or flow patterns are substantially altered for a long period of time. EWA groundwater extraction is anticipated to be limited to short-term withdrawals, and EWA extraction that could potentially induce the migration of reduced quality groundwater would be avoided through the groundwater mitigation measures Well Review (See Section 6.2.7.2 for more details.) These mitigation measures would reduce effects to less than significant levels.

The Department of Health Service monitors water quality in 339 wells throughout the North American subbasin, and the DWR monitors groundwater quality in 32 wells (DWR 2002). No significant impact related to the use of reduced quality water would be likely; however, the mitigation measures would reduce any such impacts to less than significant levels. To reduce these impacts, in addition to this monitoring, the groundwater mitigation measures specify that SGA's monitoring program for an EWA groundwater purchase transfer would monitor groundwater quality within the local pumping area. If there were to be unanticipated adverse groundwater quality effects as a result of the transfer, the groundwater mitigation measures specify that SGA would be responsible for mitigation of any adverse effects.

Multi-Year Acquisition and Purchase During Dry Years: As discussed above, during dry years, groundwater use increases and percolation from natural runoff is often lower than normal, causing groundwater levels to decline more than in normal and wet years. Furthermore, when dry years occur consecutively, groundwater levels are likely to continue to decline until a wet period enables groundwater levels to recover. In addition, groundwater levels may not fully recover from a preceding year's transfer. (As previously mentioned, this occurred in portions of the North Yuba subbasin in the 1991 State Drought Water Bank Transfer). Groundwater transfers over several consecutive years may increase the potential for adverse effects by causing net groundwater levels to decline.

The EWA's effects on groundwater levels during multi-year transfers or during dry years could be potentially significant. To reduce these effects , local management and the groundwater mitigation measures provide guidelines to evaluate groundwater levels prior to each EWA transfer. If groundwater levels prior to a proposed purchase were low relative to previous years, a pre-purchase evaluation would be performed to evaluate regional groundwater levels and potential drawdown. (See Section 6.2.7.2 for further details.) If the Review Team concluded that significant regional effects were probable, the EWA Project Agencies would not purchase water via groundwater substitution for the given hydrologic year, or they would request changes in the transfer mechanisms from the willing sellers. In contrast, if the Review Team concluded that the likelihood of regional effects would be minimal, then the transfer could commence. All sellers to the EWA Project Agencies should have a monitoring and mitigation program in place to address adverse effects should they occur. These mitigation measures would reduce effects to less than significant levels.

Local Groundwater Management: In 1991, the Sacramento City-County Office of Metropolitan Water Planning was formed to develop a regional water plan for the

Sacramento area. Six years of negotiations among many participant stakeholders led to the WFA adopted in 1998. The agreement consists of seven major elements designed to meet the following overall objective: "Provide a reliable and safe water supply for the region's economic health and planned development to the year 2030; and preserve the fishery, wildlife, recreational, and aesthetic values of the Lower American River." The WFA's Groundwater Element encourages the management of the limited groundwater resources in three hydrogeologic areas within Sacramento County (Water Forum 1999). The WFA area that could be affected by EWA actions includes only the "North Area," bounded on the north and east by the Sacramento County line, by the Sacramento River on the west, and by the American River on the south (Figure 6-27). Two of the major outcomes of this agreement are a recommended sustainable yield of 131,000 acre-feet for the North Area and the formation of the SGA and the American River Basin Cooperating Agencies (ARBCA) (Water Forum 1999). The paragraphs below provide additional information on the SGA and ARBCA and on the American River Basin Regional Conjunctive Use Program and Natomas Central MWC.

Sacramento Groundwater Authority: SGA is a joint powers authority that was established in 1998 to manage and protect the North Area in Sacramento County (See Figure 6-27 for the location of the North Area.) SGA's 16 member board of directors is comprised of representatives from the overlying water purveyors in the basin along with an individual representative from agriculture and an individual representative from self-supplied groundwater users (mostly parks and recreational districts).

SGA member agencies serve the needs of over 500,000 people in the Sacramento area. Current water deliveries total about 300,000 acre-feet per year, with about one-third of this from groundwater pumping and the remaining amount from surface water deliveries from the American and Sacramento Rivers. Over 70 percent of the deliveries are for municipal and industrial supplies, and about 30 percent to agriculture in the western portion of the service area.

SGA's primary mission is to protect the basin's safe yield, defined in the WFA, and water quality. Additional goals and objectives include: 1) Develop/facilitate a regional conjunctive use program consistent with the WFA. The basin has approximately 600,000 acre-feet of evacuated storage that could be exercised in such a program. The ultimate potential wet year in-lieu banking potential is about 100,000 acre-feet per year, with a potential dry year surface water exchange potential of over 50,000 per year. In the near-term (2005), facility improvements are under construction (with assistance from a $22 million Proposition 13 grant) to produce 25,000 acre-feet of dry-year surface water yield available for exchange with American River (or downstream) users; 2) mitigate conditions of regional groundwater overdraft; 3) replenish groundwater extraction; 4) mitigate groundwater contaminant migration; 5) monitor groundwater elevations and quality; and 6) develop relationships with State and Federal Agencies.

American River Basin Cooperating Agency: ARBCA was formed in 1997 to develop a regional partnership for water resources planning and conjunctive use and to develop a Regional Water Master Plan on a cooperative basis. ARBCA membership includes the SGA, water purveyors from Sacramento County, the City of Roseville, and Placer County. An SGA/ARBCA partnership is developing a regional groundwater management plan that incorporates both the Water Forum Plan and the Regional Water Master Plan (Thomas 2001).

American River Basin Regional Conjunctive Use Program: A partnership between SGA and ARBCA resulted in the American River Basin Regional Conjunctive Use Program. An outcome of the WFA, this Program intends to assist in meeting the WFA objectives, discussed above, by using the overdrafted basin in the North Area for groundwater banking. Groundwater recharge consists of either direct recharge using surface water from the American River and/or Sacramento River, or, in lieu of recharge, application of surface water substituted for groundwater. During the "exchange cycle," (groundwater substitution) the banked groundwater is substituted for surface water, allowing the surface water to remain in reservoirs. This additional reservoir water helps maintain the WFA American River flow standards for environmental purposes. The project could bank up to 40,200 acre-feet of groundwater in wet years and recover up to 25,000 acre-feet of banked water for the surface water exchange in dry years. The average annual yield is expected to be about 21,400 acre-feet per year (SGA 2001).

In addition to the local management efforts described above, the EWA Project Agencies would not purchase water from an agency unless the agency has successfully complied with the groundwater mitigation measures. Therefore, in order for the transfers discussed above to occur, SGA would have to implement the well review, monitoring, and mitigation measures outlined in the groundwater mitigation measures. *Consequently, EWA groundwater purchase transfers in the North American (River) groundwater subbasin could have potentially significant effects on groundwater levels, groundwater quality, surface water, and land subsidence. However, the groundwater transfers would be conducted in accordance with local management requirements and EWA groundwater mitigation measures (as discussed in Section 6.2.7) that would reduce these impacts to less than significant.*

6.2.4.1.3 North San Joaquin Groundwater Basin

<u>North San Joaquin Groundwater Basin Crop Idling</u>

EWA acquisition of water via the idling of cotton crops would decrease applied water recharge to the local groundwater system underlying the barren (idled) fields. Specific potential effects would be a decline in groundwater levels.

Figure 6-28 shows the areas that could be idled in both the North San Joaquin and South San Joaquin Groundwater Basins. Possible adverse effects resulting from decline of groundwater levels are not expected to be potentially significant given that:

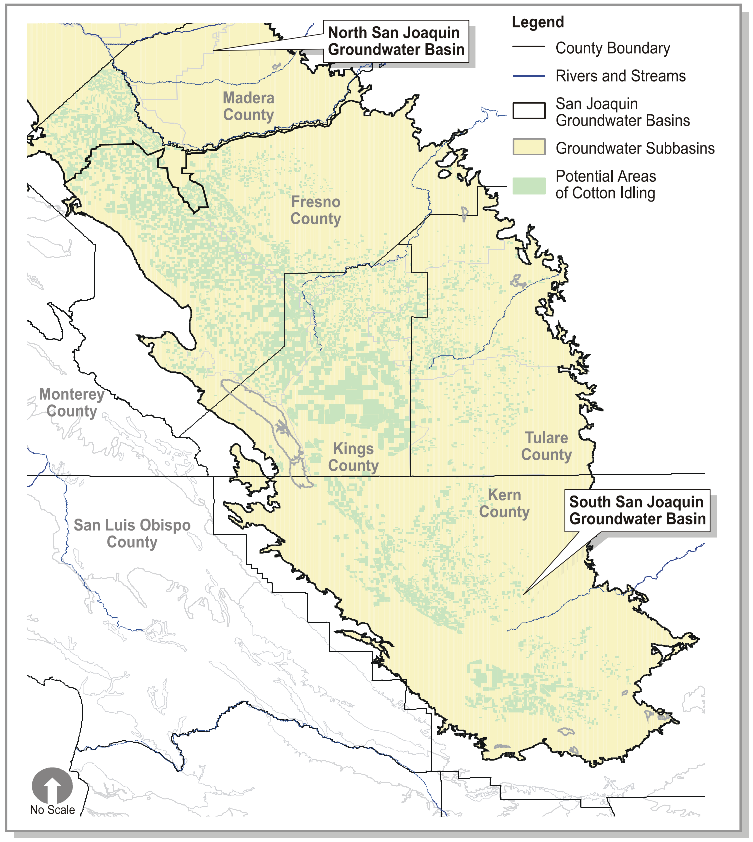


Figure 6-28
Potential Areas of Cotton Idling in the San Joaquin Valley

- Groundwater level declines would be negligible relative to the substantial historical groundwater level fluctuations that have occurred in the North and South San Joaquin Groundwater Basins over the past century. A five-year CVPIA Land Retirement Program Demonstration Project, on 7,000 acres in Westlands WD, is investigating the how land idling would affect local drainage. Water level data from the first 15 months of the study indicated that local groundwater level declines (mainly attributed to the reduction in applied recharge) ranged from only 2.4 to 3.8 feet in the shallow aquifer (Westlands WD 2000).

- Many water users in the study area rely on surface water rather than groundwater and would not be affected by groundwater level declines. The study area overlies the Corcoran Clay, in which groundwater development in the shallow aquifer is not as extensive as in the deep aquifer, because of reduced water quality and lower well yields. Two thirds of the groundwater in the Tulare Basin WSD cannot be produced economically due to reduced water quality and poor well yields (Tulare Lake WSD 1981).

- According to State Water Code Section 1745.05, crop idling transfers are limited to 20 percent of the amount of water that would have been applied in an agency for a given hydrologic year. This State Code further minimizes the potential for adverse regional effects by placing a limit on the applied water reduction. A reduction in applied recharge as a result of idling cotton fields could have an effect on groundwater recharge and levels. However, the action of crop idling of cotton fields would not substantially reduce the percentage of applied water that recharges the underlying basin.

The potential for reduction in groundwater recharge associated with the idling of cotton in the North and South San Joaquin Groundwater Basins would be less than significant.

Merced River Contractor Groundwater Substitution

EWA acquisition of Merced River Contractor water via groundwater substitution would affect groundwater hydrology. Specific potential effects would be decline in groundwater levels, decrease of water levels in neighboring surface water channels including the Merced River, increased potential for land subsidence, and degradation of groundwater quality.

Groundwater Levels: Acquisition of EWA Assets through groundwater substitution could result in temporary local declines in groundwater levels. In the Merced subbasin, groundwater levels declined by almost 30 feet from 1970 to 2000, yet increased after wet years in the late 1990s and early 2000s (DWR 2002). The greatest declines were in the southeastern, central, and northern portions of the subbasin, with the two largest cones of depression 13 miles southeast of Merced in the Le Grand-Athlone area and 17 miles northwest of Merced (MCDEH 1997). Figure 6-29 shows hydrographs of the groundwater fluctuations in these areas.

It has been estimated that the Merced groundwater subbasin is overdrafted by an average of 20,000 acre-feet per year (MCDEH 1997). This value does not readily reflect the recent change in conditions (that occurred for several years prior to 2001) that resulted in lower volumes of pumping Recently, groundwater levels have increased after several consecutive wet years (CH2M Hill 2001[b]). Since 1993, projects encouraging water conservation and in-lieu recharge have reduced the amount of groundwater Merced ID pumps and delivers to the highland areas (higher elevation areas that have historically relied solely on groundwater) from the average 27,000 acre-feet to 9,000 acre-feet, creating over 140,000 acre-feet of in-lieu recharge. These projects, in addition to Merced ID's own operational changes and conservation practices, have resulted in a total in-lieu recharge exceeding 200,000 acre-feet as of September 2001. Merced ID plans to continue these water conservation and in-lieu recharge efforts as reflected in the Merced Water Supply Update Status Report (Merced ID 2002). Because of these efforts, an EWA transfer would likely have a minimal effect on long-term groundwater level trends.

Estimates of the potential drawdown for the Merced ID resulting from an EWA agency-directed groundwater transfer have been made. Since pumping would occur throughout the agency, the entire agency service area was used to estimate a regional decline of 2 feet, assuming a maximum purchase of 25,000 acre-feet (given in Table 2-5).

Increased groundwater pumping could cause localized declines of groundwater levels, or cones of depression, near pumping wells. These declines could be larger than that indicated by the regional estimate, possibly causing effects to wells within the cone of depression. In general, groundwater supplements surface water for irrigation in this area, and represents about 51 percent of total applied water in the Merced subbasin (MCDEH 1997). Municipalities within the agency borders, of which the City of Merced is the largest, rely solely on groundwater (Merced ID 1996).

Neighboring agencies and extensive agricultural areas outside Merced ID borders also rely on groundwater. Potential adverse effects to areas relying solely on groundwater could be avoided through the Well Review process stipulated by the groundwater mitigation measures.

DWR and cooperators monitor groundwater levels in Merced subbasin semi-annually in 378 wells (DWR 2002). EWA groundwater substitution transfers could results in groundwater declines in excess of seasonal variation and these effect on groundwater levels could be potentially significant. In addition to this monitoring, the groundwater mitigation measures specify that Merced ID establish a program to monitor groundwater levels for any EWA groundwater purchase transfer. The program would monitor groundwater level fluctuations within the local pumping area and if impacts were shown or reported to be occurring, Merced ID would implement appropriate mitigation measures. These mitigation measures would reduce effects to less than significant levels.

Past Groundwater Transfers: In 2001, Merced ID conducted an investigation to assess the potential effect of transferring 25,000 acre-feet of groundwater to the EWA Program. This included a review of the historical groundwater levels and groundwater development, review of the current groundwater management plan and recent management activities, a well review, and an evaluation of groundwater modeling data. The investigation concluded that a transfer in 2001 would not result in significant impacts, and made the following observations:

- Although groundwater levels decreased during the drought in the late 1980s, the levels have increased or stabilized since the mid-1990s. The overdraft of 20,000 acre-feet is based on average conditions that do not reflect the lower volumes of pumping that had occurred for several years prior to the 2001 EWA Program transfer (CH2M HILL 2001[b]).

- Calculations prior to the transfer indicated that an additional pumping of 25,000 acre-feet for the 2001 EWA Program would only increase Merced ID’s total 2001 annual pumping amount to 33,000 acre-feet, which is below its annual average extraction of 56,000 acre-feet (CH2M HILL 2001[b]).

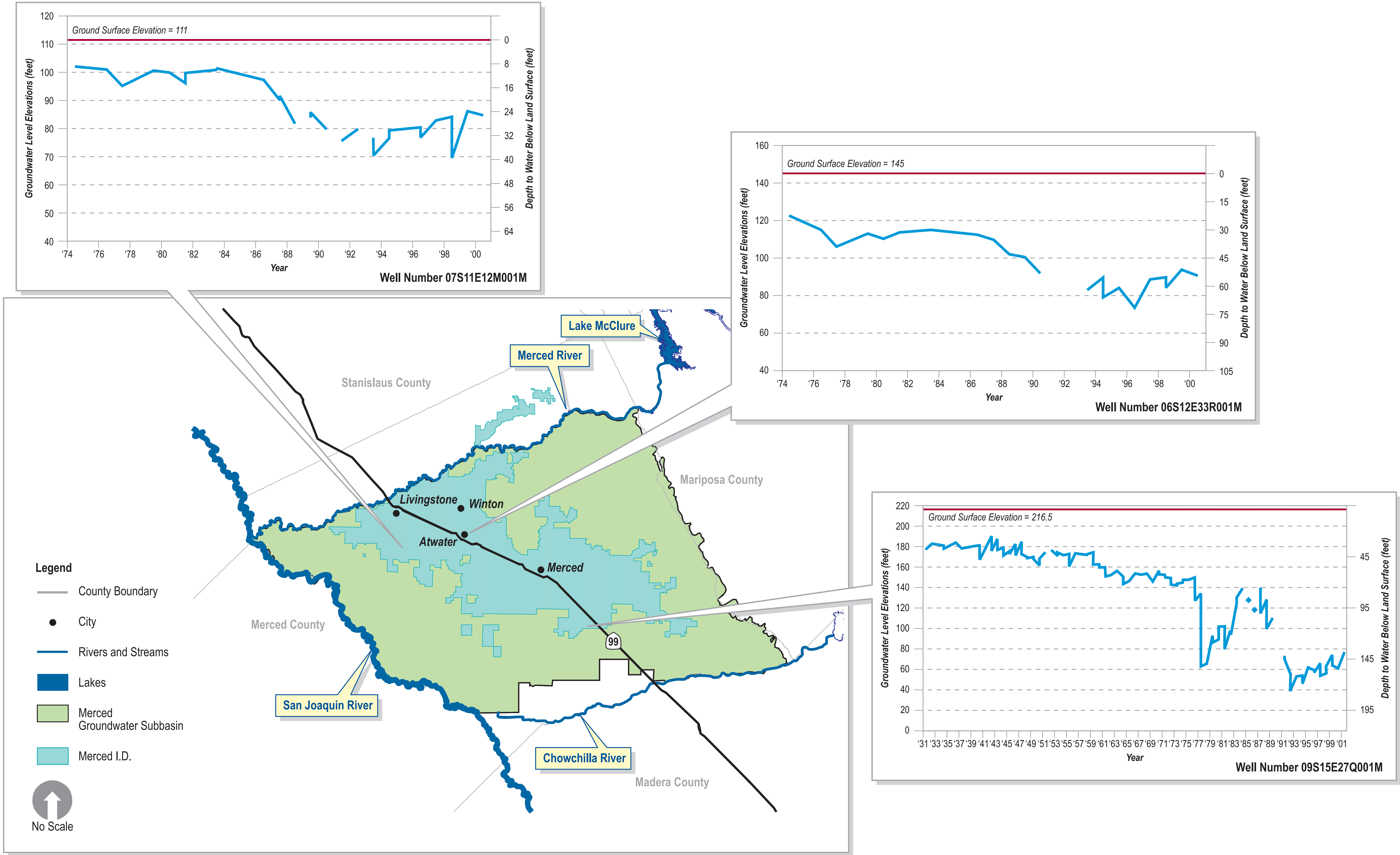


Figure 6-29
Groundwater Levels and Merced I.D. in the Merced Subbasin

- As discussed above, Merced ID implemented a series of ongoing projects intended to protect the underlying groundwater basin. An important component of Merced ID's Management Plan is the construction of additional recharge facilities. The groundwater transfer to the EWA would facilitate a phased test of Merced ID's pumping capacity and local effects on groundwater. This information would not only provide well drawdown data, but would also be useful in determining the locations of future groundwater recharge facilities (Merced ID 2001).

- All wells proposed for the transfer were reviewed. The proposed wells included about one half of the wells normally used to pump groundwater into Merced ID's surface water distribution system. The transfer was for a 60 to 75 day period, in which the active wells were spread throughout the service area, minimizing the potential for concentrated effects. Some of the wells operated full time, while the others operated 50 to 75 percent of the time (Merced ID 2001).

Although these observations are useful when considering the likelihood of effects for future transfers, hydrology, groundwater extraction, and many other variables would vary from year to year. The groundwater mitigation measures provide assurances that a well review and a monitoring and mitigation program would be established prior to every EWA transfer to address adverse effects.

Interaction with Surface Water: Pumping near the Merced River, along the northern border of the subbasin, could reduce channel flows. This could adversely affect riparian and aquatic habitats and downstream water users. Furthermore, wetlands occur throughout the Merced subbasin and pumping activities could drain or interrupt the wetlands' water supply, thus adversely affecting these habitats.

The Merced River appears to be gaining groundwater west of Highway 99, but east of the highway the river appears to be losing water to a cone of depression 17 miles northwest of Merced (MCDEH 1997). Prior to the 2001 EWA transfer, a groundwater-surface water model developed for the Water Supply Plan Update assessed the potential groundwater effects. The model results showed that the maximum rate of net groundwater discharge to the Merced River was about 65 cfs, occurring in 1970, and the maximum rate of seepage from the river was about 18 cfs in 1992 (Merced 2001). These rates are relatively small compared to the average 1992 flow in the channel of 642 cfs, measured just below Merced Falls Dam (USGS 2002). Furthermore, the wells proposed for the EWA transfer in 2001 were chosen a sufficient distance away from the river to avoid groundwater/surface water interaction effects (Merced ID 2001). Consequently, the study concluded that adverse effects to the Merced River, in response to groundwater pumping, would be minimal.

Groundwater pumping for EWA groundwater substitution transfers could reduce flows in nearby surface water bodies and these effects could be potentially significant. To reduce these effects, the groundwater mitigation measures would involve assessment of measures to avoid and minimize all potential effects prior to an EWA transfer. Through the Well Review process identified in the groundwater mitigation measures, the purchasing agency would review the location and screened interval of the proposed production wells. Production wells within 2 miles of a surface water body could need to meet well depth criteria if data were insufficient to show that pumping would not result in adverse effects. Furthermore, the Well Review may determine that pumping activities should be limited to a specified depth in some areas, in order to avoid hydraulic interaction between pumping and overlying surface water systems. In addition to the well review, , the groundwater mitigation measures provide guidance for the establishment of a local monitoring and mitigation program, designed to identify and mitigate local impacts. These mitigation measures would reduce effects to less than significant levels.

Land subsidence*:* An EWA groundwater substitution transfer could contribute to land subsidence if groundwater level declines were to exceed historical levels; however, declines are expected to be minimal. Currently, Merced ID relies on field inspection at the wellheads by local maintenance crews and on information from adjacent water users for information concerning land subsidence (Selb 2002). No subsidence has been observed and as previously discussed, Merced ID is implementing a variety of measures intended to minimize groundwater declines, thus reducing the potential for future land subsidence.

Additional monitoring may be necessary, depending on the hydrology, expected groundwater use, and the extraction Merced ID plans to pump under the Flexible Purchase Alternative. EWA groundwater substitution transfers could decrease groundwater levels that could cause potentially significant effects on land subsidence. To reduce these effects, the groundwater mitigation measures stipulate that all sellers to the EWA Project Agencies have a monitoring and mitigation program in place to address potential land subsidence effects. The level of monitoring for land subsidence may be negotiated between the Review Team and the selling agency prior to the transfer. These mitigation measures would reduce effects to less than significant levels.

Groundwater Quality*:* The migration of reduced quality groundwater and the distribution of reduced quality groundwater are the two types of potential water quality effects associated with increased groundwater withdrawals related to EWA asset acquisition from the Merced ID.

The Migration of Reduced Groundwater Quality: Groundwater quality in Merced ID is generally good, with TDS concentrations ranging from 200-400 mg/L Elevated levels of hardness, iron, nitrate, and chloride occur in localized areas through the subbasin (DWR 2002). Inducing the movement or migration of reduced quality water into previously unaffected areas through groundwater pumping is not likely to be a concern unless groundwater levels and/or flow patterns are substantially altered for a long period of time. EWA groundwater extraction is anticipated to be limited to short-term withdrawals during the irrigation season and EWA extraction near areas of reduced groundwater quality concern would be avoided through the groundwater mitigation measures Well Review (See Section 6.2.7.2 for more details.) Consequently, adverse effects from the migration of reduced groundwater quality would be minimal.

Distribution of Reduced Quality Water: Groundwater extracted for an EWA transfer may be of reduced quality relative to the surface supply allotment the agency normally receives. However, because groundwater is generally of good quality, potential regional impacts would be minimal. Therefore, no significant impacts related to the distribution of reduced quality water would be likely.

Merced ID has monitored groundwater pumping monthly since 1943 in a network of monitoring wells and began monitoring water levels at the beginning and end of the irrigation season in its production wells in 1959 (MID 1996). Currently, the district measures 196 active wells and other shallow monitoring wells in areas of high or perched groundwater on a monthly basis. In addition, the City of Merced monitors groundwater quality from the water supply wells. The Merced County Division of Environmental Health also monitors individual domestic wells (MCDEH 1997).

Additional assurances are provided by the groundwater mitigation measures that specify that Merced ID have a monitoring and mitigation program in place that addresses potential adverse groundwater effects. If adverse effects to groundwater quality as a result of a transfer were to occur, the groundwater mitigation measures further specify that Merced ID mitigate any impacts.

Multi-Year Acquisition and Purchase During Dry Years: During dry years, groundwater use increases and percolation from natural runoff is often lower than normal, causing groundwater levels to decline more than during normal and wet years. Furthermore, when dry years occur consecutively, groundwater levels are likely to continue to decline until a wet period occurs when groundwater levels may recover. In addition, groundwater levels may not fully recover from a preceding year's transfer. Groundwater transfers over several consecutive years may increase the potential for adverse effects by causing net groundwater levels declines.

The EWA's effects on groundwater levels during multi-year transfers or during dry years could be potentially significant. To reduce these effects, local groundwater management and the groundwater mitigation measures provide guidelines to evaluate groundwater levels prior to each EWA transfer. If groundwater levels prior to a proposed purchase were low relative to previous years, a pre-purchase evaluation would be performed to evaluate regional groundwater levels and potential drawdown. (See Section 6.2.7.2 for further details.) If the Review Team concluded that significant regional effects were probable, the EWA Project Agencies would not purchase water via groundwater substitution for the given hydrologic year, or they would request changes in the transfer mechanisms from the willing sellers. In contrast, if the Review Team concluded that the likelihood of regional effects would be minimal, then the transfer could commence. The groundwater mitigation measures further stipulate that all sellers to the EWA Project Agencies should have a monitoring and mitigation program in place to address adverse effects if they should occur. These mitigation measures would reduce effects to less than significant levels.

Local Groundwater Management: The City of Merced and the Merced ID developed a water supply plan during 1995 that was subsequently updated in 2001. This plan incorporated a variety of strategies, planning scenarios, and groundwater and strategic modeling tools to recommend a set of immediate actions to meet the water demands through the year 2030. These actions include additional groundwater recharge facilities, groundwater to surface water irrigation conversion, the repair and maintenance of existing facilities, technology enhancements, and various irrigation efficiency programs (CH2M Hill 2001, MID 2001).

Merced ID and the surrounding water agencies in the Merced subbasin have also developed AB3030 Groundwater Management Plans (Table 6-2 shows the components included in the plans). The goal of Merced ID's 1996 Groundwater Management Plan is to maintain the long-term average groundwater level at 1990 levels while meeting the region's water demand. To achieve this goal, Merced ID would vary operations depending on conjunctive use capabilities in local areas, local water needs, and the desired groundwater level. The District's General Manager implements and manages the Plan in accordance with the Board of Directors. The Plan covers Merced ID's service area south of the Merced River. The Turlock ID Groundwater Management Plan, adopted in 1993, covers the service area north of the Merced River. In 1997, the Merced Area Groundwater Pool Interests developed the Merced Groundwater Basin Groundwater Management Plan, which covers the entire Merced ID service area and neighboring water users within the subbasin. Pursuant to the AB3030 Water Code, both groundwater management plans include provisions for coordination between the two plans (MID 1996).

In addition to the local management efforts described above, the EWA Project Agencies would not purchase water from a district unless the district had successfully complied with the groundwater mitigation measures. Therefore, for the transfers discussed above to occur, Merced ID should determine whether a pre-purchase evaluation is necessary and implement the well review, monitoring, and mitigation measures outlined in the groundwater mitigation measures. *Consequently, EWA groundwater substitution transfers of Merced River Contractor groundwater in the North San Joaquin groundwater basin could have potentially significant effects on groundwater levels, groundwater quality, surface water, and land subsidence. However, the groundwater transfers will be conducted in accordance with local management requirements and EWA groundwater mitigation measures (as discussed in Section 6.2.7) that will reduce these impacts to less than significant.*

6.2.4.2 Export Service Area

EWA acquisitions that could affect groundwater resources in the Export Service Area include crop idling, groundwater purchase, and groundwater storage. The effects associated with these acquisitions include groundwater level declines, alteration of surface and groundwater hydrology, land subsidence, and changes in groundwater quality. This discussion covers potential effects as a result of crop idling at a regional scale and groundwater substitution and groundwater purchase at a local scale.

6.2.4.2.1 South San Joaquin Groundwater Basin Crop Idling

EWA acquisition of water via cotton crop idling would decrease applied water recharge to the local groundwater system underlying the barren (idled) fields. Specific potential effects would be a decline in groundwater levels.

Figure 6-28 shows the areas that could be idled in both the North San Joaquin and South San Joaquin Groundwater Basins. Adverse effects resulting from decrease of groundwater recharge are expected to be less than significant. Section 6.2.4.1.3, North San Joaquin Groundwater Basin Crop Idling, discusses this conclusion in more detail.

6.2.4.2.2 South San Joaquin Groundwater Basin Banked Groundwater

EWA acquisition of banked groundwater from potential water bank participating agencies in Kern County, via groundwater purchase and recovery through direct extraction from the banking facilities, could decrease groundwater levels. Specific potential effects would be declines in groundwater levels, increased potential for land subsidence, degradation of groundwater quality, and the reduction of groundwater available for future transfers.

There are two recovery methods for the acquisition of banked groundwater in Kern County: exchange and direct pumpback recovery. During an exchange recovery, Kern County WA exchanges water from the SWP stored in San Luis Reservoir for banked groundwater. Water is released from the San Luis reservoir, while the banked groundwater physically remains in storage and is reaccredited as water from the SWP. During a direct pumpback recovery, groundwater is directly extracted from the banking facility and conveyed into the California Aqueduct for the EWA asset management (Bucher 2002).

Groundwater Levels*:* Groundwater in the South San Joaquin Groundwater Basin has historically been used heavily, and excessive groundwater withdrawals have caused substantial declines in groundwater levels. Figure 6-30 shows the groundwater levels of wells in Semitropic WSD, Arvin-Edison WSD, and Kern Fan Element Banking facilities. As shown, groundwater levels have substantially increased relative to pre-project groundwater levels in these banks.

EWA groundwater purchase and direct extraction from these banking facilities could result in declines of groundwater levels; however, the levels would generally remain higher than they would have been absent the banks. In contrast to the affected subbasins discussed previously, no estimated groundwater declines exist for this region. Groundwater banking agencies have policies that do not allow greater extraction of groundwater than the project has banked. Banking participants have signed MOUs and Agreements to monitor and regulate these declines. Table 6-17 lists the MOUs, Agreements, and environmental documents that have been developed for each bank that may provide water to the EWA Project Agencies.

Table 6-17
Documents Pertaining to Banking Operations, Monitoring, and Mitigation

Groundwater Bank	Agreements/MOUs/Plans	Environmental Documents
Kern Water Bank	• MOU Regarding Operation and Monitoring of the Kern Water Bank Groundwater Banking Program, Oct 1995 • Joint Powers Agreement for the KWB Authority, Oct 1995. • • Proposed Monitoring Plan for the Kern Fan Element of the KWB, 1995 • Standard Scheduling and Payment Provisions for Banking and Recharge Projects, Feb 1997	• Final EIR, Artificial Recharge, Storage and Overdraft Correction Program, Dec 1986. • Monterey Addendum which includes Volume IV (NEPA/CEQA) of the KWB Habitat Conservation Plan (HCP) Oct 1997
Pioneer Groundwater Recharge and Recovery Project	• MOU Regarding Principles Governing Implementation of the Pioneer Project, Dec 1995 • Pioneer Project Joint Operating Agreement, Oct 1996 • Agreement with COB on the Coordinated Operation of Recharge and Recovery Project located on the Kern River Fan, Dec 1996 • The Pioneer Project Participation Agreement, May 1998 • Proposed Monitoring Plan for the Kern Fan Element of the KWB, 1995 • Standard Scheduling and Payment Provisions for Banking and Recharge Projects, Feb 1997	• Negative Declaration for the Pioneer Groundwater Recharge and Recovery Project, November 1996
Berrenda Mesa Project	• Agreement Regarding Joint Water Banking Project on the Berrenda Mesa Property, Oct 1999 • MOU Between Berrenda Mesa WD and Kern County WA for Developing and Operating a Joint Water, Aug 1992Recharge/Recovery Project, Aug 1992 • Proposed Monitoring Plan for the Kern Fan Element of the KWB, 1995 • Standard Scheduling and Payment Provisions for Banking and Recharge Projects, Feb 1997	
Semitropic Groundwater Banking Project	• MOU between Semitropic WSD and the Adjoining Entities, Sep 1994	• Stored Recovery Unit Final Supplemental EIR – Findings and Mitigation Monitoring Plant, Jan 2000 • Stored Recovery Unit Final Supplemental EIR, Jan 2000 • Semitropic WSD. Semitropic Groundwater Banking Project Draft EIR, Mar 1994
Arvin-Edison	• Agreement Between Arvin-Edison WSD and MWD of Southern California for a Water Management Program, Dec 1997	• EIS for MWD and Arvin Agreement

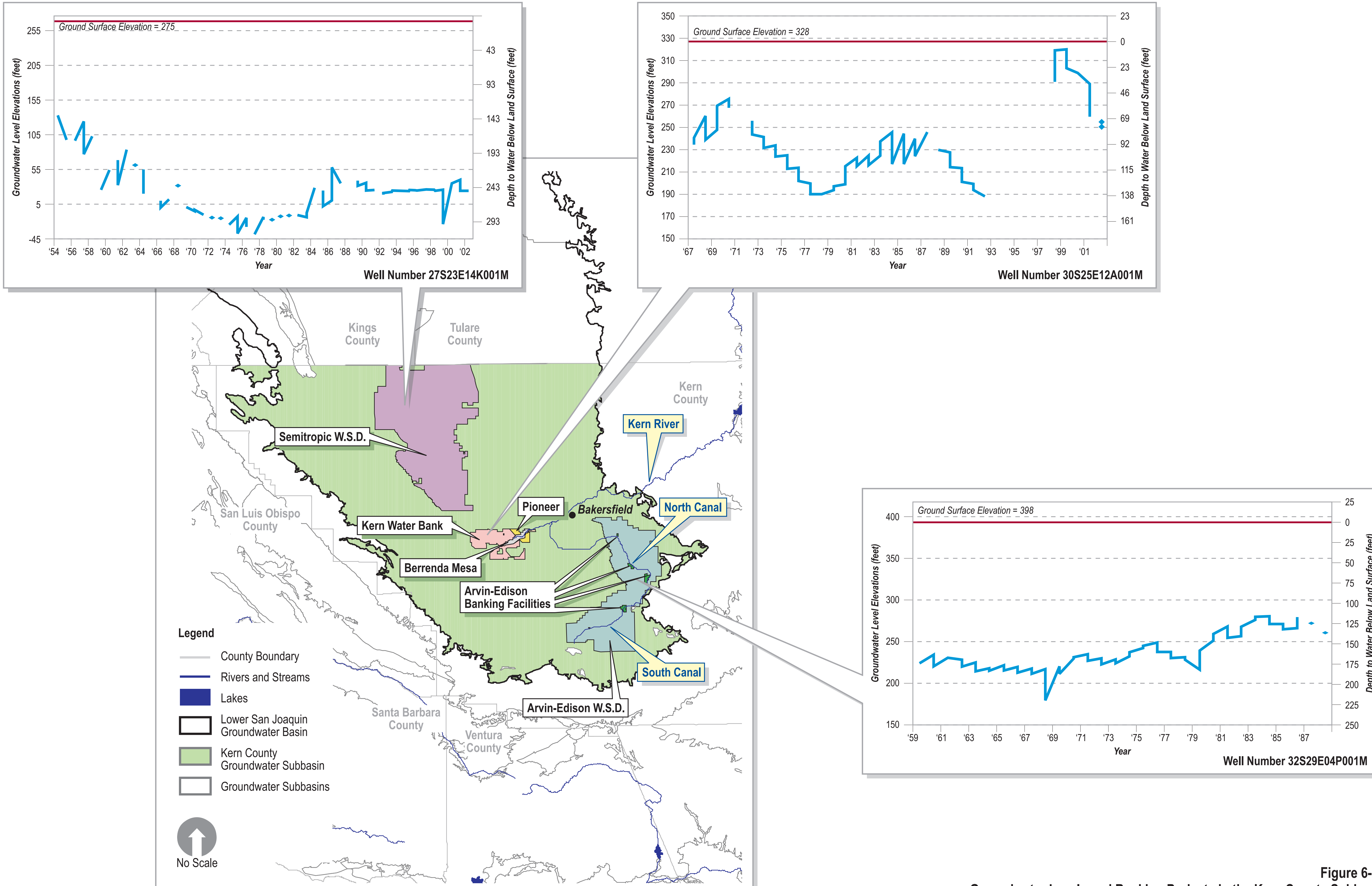


Figure 6-30
Groundwater Levels and Banking Projects in the Kern County Subbasin

The following paragraphs describe groundwater level monitoring activities within the banks.

Kern Fan Element: The "MOU Regarding Operation and Monitoring of the Kern Water Bank Groundwater Banking Program" (Monitoring MOU), applies to the Pioneer, Berrenda Mesa, and KWB projects within the KWB Fan Element. According to this memorandum, all disputes must be submitted initially to the Monitoring Committee for review. Following a technical evaluation, the Monitoring Committee is to offer a fair resolution. This resolution may entail operational changes and/or mitigation measures. The Monitoring MOU also provides a list of suggested mitigation measures that may be implemented to address adverse effects (KCWA 1995a).

In 2001, a relatively high amount of groundwater was recovered from the Kern Fan groundwater banking projects. An operator of a well field near the Kern Fan Element expressed concern to the Monitoring Committee about the relatively large drawdown that was occurring within proximity to the subject's well field. The Monitoring Committee consulted with a professional hydrogeologist who, following a technical review, concluded that the subject's well field would not be adversely affected if pumping from the groundwater banks continued. Following this review, additional monitoring was conducted in the area as a precautionary measure. The monitoring results verified that the well field was not at risk from the Kern Fan groundwater banking extraction (Iger 2002).

Semitropic WSD: In addition to the agreements in Table 6-17, Semitropic WSD has established a "15-foot, three year rule" that applies to the existing banking facilities and the proposed new well field. This rule states: "withdrawals would be stopped or modified at specific locations if such withdrawals would cause the average groundwater level over a 3-year period to be 15 feet less than what the average would have been without the Project over the same 3-year period" (Semitropic WSD 1994a). Semitropic WSD has installed additional wells to monitor groundwater levels and quality and to identify effects if they occur (Semitropic WSD 1994a).

Arvin-Edison WSD: Direct extraction of the purchased banked water from the Arvin-Edison Banking facilities must adhere to the "Agreement Between Arvin-Edison WSD and MWD for a Water Management Program." This agreement specifies a set of operational parameters agreed upon by local landowners and the neighboring district, Kern-Delta WD. These parameters are designed to avoid effects to purveyors within the Arvin-Edison District and to Kern-Delta WD. Arvin-Edison WSD monitoring includes monthly measurement of water levels from 72 monitoring wells during recovery operations, semi-annual groundwater level surveys district wide, and a district wide annual hydrologic inventory that includes a water level survey (Lewis 2002).

The MOUs, Agreements, and monitoring programs developed by these banks provide assurances that Kern County WA and/or the participating banking agencies have a sufficient level of monitoring and management to address effects if they occur. Kern County WA and/or the participating Kern County WA banking agencies are responsible for implementing mitigation measures. Such mitigation measures would reduce any effects to less than significant.

Water Transfer History with the EWA Program: Kern County WA has participated in a number of transfers. Because of the large number and complexity of these past transfers, this document focuses on the transfers conducted within the EWA Program in 2000 and 2001.

The Monterey Amendment[16] to the SWP contracts has increased water management flexibility for SWP contractors, improving their ability to manage their groundwater resources. However, all EWA acquisitions from member districts of Kern County WA must be approved by Kern County WA. For transactions involving banked SWP water, SWP contracts prohibit the sale of banked SWP water. CVP contracts also place limitations on potential sales of Friant-Kern CVP water. A place-of-use restriction requires the use of banked Friant-Kern groundwater to be within county limits. Consequently, these agreements legally limit the classification of water that may be sold to the EWA Project Agencies. Current Kern County WA policy and SWP contracts place limitations on the sale of banked SWP water, and CVP contracts place further limitations on potential sales of Friant-Kern CVP water.

To establish the EWA Program, the DWR and Kern County WA made an exception to this policy during the initial operating years of the EWA in 2000 and 2001. Water from the SWP, banked in the hydrologic years of 1995-1999, was sold to the EWA Project Agencies. The rationale for using the 1995-1999 years was that these were wet years, and a surplus of water was available. All of the Kern Water Bank member agencies either used and/or stored their entire SWP allocations, continually recharging the underlying groundwater basin. The sale of 1995-1999 water from the SWP may continue until all supplies have either been used or sold to the EWA Project Agencies (Bucher 2002).

Table 6-18 summarizes the water agencies and water banks involved in the sales that Kern County WA made to the EWA Project Agencies in 2000 and 2001. No effects resulting directly from EWA-related transfers have been reported to DWR.

---

[16] The Monterey Amendments to the SWP contracts enhance management of SWP supplies and operations. This amendment established a number of water management tools including: 1) Turn-back pool - SWP contractors may sell unwanted SWP Table A amounts through a "turn back pool" to other contractors; 2) Water Transfers - Subject to DWR approval, SWP Contractors may permanently transfer Table A amounts to other SWP Contractors, 3) Storage Outside the Service Area - SWP Contractors may store water outside of their service areas for use in their SWP service area at a later date; and 4) Flexible management of SWP terminal reservoirs - Contractors may store water in certain SWP facilities in Southern California and withdraw excess deliveries from these facilities for a limited time.

Table 6-18
Sales by Kern County WA to the Environmental Water Account in 2000 and 2001

Seller	Amount (AF)	Banked Groundwater Type	Groundwater Banking Facility or Agency	Date Water Released to EWA
2000 SWP Table A Allocation Exchange Water Purchased and Delivered in 2000				
Kern Water Bank Participants	31,555	Friant-Kern Flood	KWB	7/00
	40,725	Kern River Flood	KWB	8/00
2000 SWP Carryover Table A Allocation Exchange Water Purchased and Delivered in 2001				
Arvin-Edison	10,000	Friant-Kern Flood	Arvin-Edison WSD	3/01
Rosedale Rio Bravo	19,036	Friant-Kern Flood	Rosedale Rio Bravo WSD	3/01
Westside Mutual Water Co.	15,000	SWP Table A Allocation	KWB	3/01
2000 SWP Exchange Subtotal	116,316			
2000 SWP Table A Allocation Exchange Water Purchased and Delivered in 2001				
Kern County WA for Nickel Family LLC[1]	10,000	Kern River Flood	Pioneer Project	5/01
Kern County WA/ID	10,000	Kern River Flood	KWB	6/01
Buena Vista/ Rosedale/ West Kern	20,218	SWP Table A Allocation	Buena Vista WSD	5/01
Buena Vista/ Rosedale/ West Kern	1,000	SWP Table A Allocation	Buena Vista WSD	5/01
Buena Vista/ Rosedale/ West Kern	2,500	SWP Table A Allocation	Buena Vista WSD	7/01
Semitropic WSD	10,767	SWP Table A Allocation	KWB	10/01
Semitropic/ Tulare ID	4,233	Friant-Kern [2]	Semitropic WSD	11/01
Westside Mutual/Tejon Castaic	21,000	SWP Table A Allocation	KWB	10/01
Cawelo WD	5,000	SWP Table A Allocation	KWB[3]	11/01
2001 SWP Exchange Subtotal	84,718			
2000 & 2001 Total	201,034			

Source: KCWA 2002

[1] The Nickel Family LLC is a private company primarily invested in farming. Nickel was the owner of a pre-1914 Kern River Water Right, referred to as the Lower River Water Rights. KCWA recently purchased the Lower River Rights from Nickel, and as part of the deal, Nickel is supplied with 10,000 AF of water per year by KCWA. Nickel banks this water in KCWA's portion of the Pioneer Project.

[2] Tulare ID delivered non-CVP water to Semitropic WSD via a Friant-Kern exchange.

[3] Westside Mutual pumped its KWB account in exchange for a like amount of Cawelo's 2800-acre account that was assigned to Belridge on behalf of Westside Mutual.

Interaction with Surface Water: The interaction of groundwater and wetlands in the Kern Fan Element are addressed in the Final EIR, Artificial Recharge, Storage and Overdraft Correction Program, December 1986, and the Monterey Addendum, which includes Volume IV (NEPA/CEQA) of the KWB Habitat Conservation Plan (HCP) Oct 1997. Groundwater underlying the Semitropic WSD and Arvin-Edison WSD is deep enough to be hydraulically disconnected from the surface water. Transfers to the EWA would not result in significant adverse impacts to the minor surface water features.

Land Subsidence*:* Both Arvin-Edison WSD and the Kern Fan Element have experienced substantial drawdown in the past, with a maximum subsidence rate (as of 1970) in excess of 0.5 feet per year observed in the Arvin-Maricopa area, and a total maximum approaching 9 feet (centered west of the Arvin-Edison WSD within the eastern portion of the Kern-Delta WD). The majority of this subsidence was attributed to overdraft of groundwater. An evaluation of subsidence in the Arvin-Edison WSD has not been performed since 1975; however, groundwater levels have stabilized and recovered significantly. Since 1980, subsidence related effects have not been observed in the Arvin-Edison WSD as a result of improvement in the water balance and stabilization of groundwater levels as a result of their Groundwater Management Plan (Arvin-Edison WSD 2003). Historical land subsidence has also been observed in Semitropic WSD, as shown in Figure 6-16, with subsidence of up to 8 feet since 1948 (Semitropic 1994a). The CEQA environmental review addressed the potential for further subsidence from the Semitropic Banking Project, and concluded that banking activities would not decrease groundwater elevations below that which would have occurred if Semitropic WSD had not established a bank. Consequently, this review concluded that the banking project would not induce subsidence.

Similarly, transfers under the Flexible Purchase Alternative would not result in drawdown that exceeds historical groundwater level declines. The operational parameters within the Kern Fan specify that groundwater levels are not to decrease beyond the pre-project groundwater level conditions.(KCWA 1995a). Therefore, the potential for land subsidence would not be increased (Iger 2002). Operational parameters are similar for the Semitropic WSD and Arvin-Edison WSD banking projects. Consequently, although groundwater transfers to EWA Project Agencies would lower groundwater levels, there would be minimal chance for adverse land subsidence effects, and any effects would be less than significant.

Groundwater Quality: The migration of reduced quality groundwater and distribution of reduced quality water into the aqueduct system are two types of potential water quality effects associated with increased groundwater withdrawals for EWA asset acquisition. The banking projects' MOUs, agreements, and monitoring activities address many of these groundwater quality concerns.

Groundwater in the Kern Fan Element banking projects is monitored routinely for TDS and constituents that may be of concern, including DBCP, EDB, and nitrates. These constituents have been detected at elevated concentrations in shallow groundwater north of the Kern River and west of Enos Lane. Uranium is also monitored in several areas of concern, and arsenic was recently added as an element to monitor. Additionally, California Code of Regulations Title 22 drinking water analyses of public supply wells in the local area and neighboring agencies actively monitor groundwater quality (KCWA 1995c).

The 1995 Proposed Monitoring Plan for the Kern Fan Element of the Kern Water Bank specifies a list of mitigation measures that are intended to protect groundwater quality. These mitigation measures include 1) the banking projects should be operated such that the TDS concentrations of recharged water does not exceed the TDS of recovered water; 2) purveyors should attempt to control the migration of reduced quality water; and 3) problem areas may be addressed either by limiting those pumping/recharge activities that enhance the migration of reduced quality water or by increasing extraction that may result in beneficial groundwater gradients (KCWA 1995c).

Groundwater quality concerns within Semitropic WSD include localized high concentrations of salinity and two landfills that could be point sources of contamination. The EIS Reports for the original Semitropic Banking Project concluded that in-lieu recharge and extraction would take place primarily in the lower confined aquifer, and would not significantly affect the shallow aquifer in which the potential contamination is located. Furthermore, the banking project would result in higher groundwater levels than without project conditions, thus inhibiting the migration of reduced quality water . The installation of additional monitoring wells, solely for the purpose of monitoring groundwater quality , mitigated potential effects to a less than significant level. The placement and operation of these wells are consistent with the criteria set forth in a February 1992 draft KWB Groundwater Monitoring Program that was designed originally for the banking projects in the Kern Fan Element (Semitropic WSD 1994). For any new groundwater storage unit, additional monitoring wells are to be installed in the northwestern section of the district to monitor for groundwater levels and groundwater quality (Semitropic WSD 2000b).

Arvin-Edison WSD monitors groundwater quality annually in 50 to 70 wells and canals throughout the district. Constituents of concern are arsenic and nitrates. The historic decline of the water table has induced migration of high boron concentrations from the east. There are some indications that this migration has been reduced through conjunctive use efforts. Generally, the groundwater is considered to be of good quality, with constituents below MCL standards, yet constituents have exceeded background concentrations present in the California aqueduct (Lewis 2002). If water quality declines below the threshold concentration specified in the MWD/Arvin-Edison agreement, Arvin-Edison WSD has agreed to purchase the water from MWD for the price at which it would purchase Class 2 (lower quality) Friant-Kern supplies (Arvin-Edison 1997).

In addition to the monitoring activities in the Kern Fan Element and the water quality control measures incorporated into Semitropic and Arvin-Edison's operations, the *Interim DWR Water Quality Criteria for Acceptance of Non-Project Water into the SWP* protects the quality of the water transported within SWP aqueducts. All groundwater that is directly pumped from the banking projects and conveyed into the California aqueduct must comply with criteria requiring that all non-Project water entering the SWP aqueducts remain within or exceed historical water quality levels. Prior to the transfer, an established facilitation group must review the request for input and the DWR must give final approval (DWR 2001).

A series of MOUs, agreements, and monitoring activities have been established to monitor and regulate groundwater quality in Kern County. (See Local Groundwater Management below for more information.) If impacts were shown or reported to be occurring, Kern County WA and the participating Kern County WA member agencies would be responsible for implementing mitigation measures.

Multi-Year Acquisitions: The acquisition of banked groundwater for consecutive years could reduce the amount of banked groundwater available in subsequent years. As discussed previously, a series of MOUs, agreements, and monitoring activities monitor and regulate groundwater levels, minimizing the potential for adverse effects. If these activities determine that existing groundwater levels are at a level that could result in adverse effects if a transfer occurs, the transfer would not be allowed to proceed, which would limit the amount of water available to the EWA Program.

Local Groundwater Management: Groundwater transfers to the EWA Project Agencies must meet Kern County WA approval. Kern County WA serves as an "umbrella organization" that acquires water from the SWP and sells the water to its member agencies within the county. Kern County WA must approve of all water that enters or leaves the county and also reserves the right to control flood and storm water, drain and reclaim land, store and reclaim water, protect groundwater quality, and conduct investigations involving water resources. Kern County WA serves as an important intermediate link and resource organization representing local interests at the State level.

Operations of the Kern County groundwater banks (by the owners/sponsors listed in Table 6-3) must adhere to the MOUs and Agreements (Table 6-17) signed by these participating agencies. Groundwater transfers to the EWA Project Agencies must not only meet the approval of Kern County WA, but also must gain the approval of the banking participants and meet the operation criteria set forth by the MOUs and agreements. These MOUs and agreements specify operational parameters and priorities for participating entities, monitoring requirements, and mitigation strategies. *Consequently, all potential impacts associated with the groundwater purchase and direct recovery operations conducted in accordance with local groundwater management requirements for the EWA Program would be less than significant.*

<u>South San Joaquin Groundwater Basin Groundwater Storage</u>

Acquisition of groundwater storage capacity for EWA acquisition water in Semitropic WSD or Arvin-Edison WSD's groundwater banking facilities would change groundwater levels. This could result in potential adverse impacts generally associated with groundwater banking facilities, including groundwater level declines when groundwater is extracted, land subsidence, and groundwater quality degradation.

The assessment of Kern County WA groundwater purchase effects above discusses potential effects in both Semitropic WSD and Arvin-Edison WSD. The acquisition of storage capacity for EWA water would result in the same potential effects as those listed above. As shown in Table 6-17, Semitropic WSD and Arvin-Edison WSD currently have established MOUs/agreements with participating banking and adjoining agencies. It is anticipated that if the EWA became an active banking participant by storing EWA water in either Arvin-Edison WSD or Semitropic WSD, the EWA Program would also have an operating agreement or MOU that would address potential adverse effects. These agreements would address the mitigation of potential adverse effects associated with groundwater banking activities, including periodic groundwater level declines caused by groundwater extraction, land subsidence, and groundwater quality degradation. *Consequently, for groundwater transfers conducted in accordance with local management, the potential groundwater impacts would be less than significant.*

Groundwater storage of EWA acquisition water in Semitropic WSD or Arvin-Edison WSD's groundwater banking facilities could change groundwater levels and would provide benefits.

As previously discussed, groundwater resources in Semitropic WSD and Arvin-Edison WSD have experienced overdraft conditions in past years. Although groundwater levels have increased since the beginning of banking operations (Figure 6-30), a large amount of storage capacity is available in the underlying aquifer. The purchase of storage space for EWA water (used to recharge the underlying aquifer) would increase the EWA agencies' operational flexibility because EWA assets could be stored if they were available at times that they could not be used immediately. The banked EWA water would also benefit Semitropic WSD and Arvin-Edison WSD by increasing groundwater levels in their underlying basins.

6.2.5 Environmental Consequences/Environmental Impacts of the Fixed Purchase Alternative

The Fixed Purchase Alternative specifies purchases of 35,000 acre-feet from areas Upstream from the Delta Region and 150,000 acre-feet from the Export Service Area. While the amounts in each region are fixed, the acquisition types and sources could vary. In this section, the effects of each potential transfer are analyzed to allow the EWA Project Agencies maximum flexibility when negotiating purchases with willing sellers. The possible transfers for the Fixed Purchase Alternative are the same as the Flexible Purchase Alternative, but the total quantity of water acquired would be limited by the total acquisition amount in each region (35,000 acre-feet from the areas Upstream from the Delta Region and 150,000 acre-feet from the Export Service Area).

Despite the differences in transfer quantities between the two Purchase Alternatives, the acquisition areas are the same; consequently, the type of potential adverse effects for the Fixed and Flexible Purchase Alternative in each Region are the same. The following text lists the potential effects for each of the groundwater subbasins and provides regional drawdown estimates, if they differ from the Flexible Purchase Alternative estimates. The regional drawdown estimates differ in acquisition areas where the maximum amount of water that may be transferred, given in Table 2-9, exceeds the total Fixed Purchase acquisition cap. Because the kinds of adverse effects would be the same with both Purchase Alternatives, the majority of discussion on the potential effects is referred to Section 6.2.4, Environmental Consequences/Environmental Impacts of the Flexible Purchase Alternative.

6.2.5.1 Upstream from the Delta Region

EWA Project Agency acquisitions that could affect groundwater resources in the areas Upstream from the Delta Region include groundwater substitution, groundwater purchase, and crop idling. The effects associated with each of these acquisitions would be groundwater level declines, alteration of surface and groundwater hydrology, land subsidence, and changes in groundwater quality.

This discussion covers the effects of crop idling at a regional scale and the potential effects of groundwater substitution and groundwater purchase at the local scale. Section 6.2.5.1.1 below covers the Redding Groundwater Basin. Section 6.2.5.1.2 covers the Sacramento Groundwater Basin, which includes the Colusa, East Butte, West Butte, East Sutter, North Yuba, South Yuba, and North American subbasins.

6.2.5.1.1 Redding Groundwater Basin

EWA acquisition of Sacramento River Contract water in the Redding groundwater subbasin via groundwater substitution could affect groundwater hydrology. The potential effects would be decline in groundwater levels, interaction with surface water, land subsidence, and water quality impacts. Groundwater substitution would most likely be concentrated in Anderson-Cottonwood ID.

The maximum Fixed Purchase acquisition amount of 35,000 acre-feet is less than the maximum acquisition of 40,000 acre-feet for the Flexible Purchase Alternative. Consequently, the regional groundwater drawdown estimates differ. Table 6-19 shows the estimated regional drawdown relative to typical seasonal groundwater level fluctuations in normal and drought years for the Fixed Purchase Alternative.

Table 6-19
Fixed Alternative Estimate of the Groundwater Drawdown for the Redding Basin

EWA Acquisition Range	10,000 to 35,000
Estimated Regional Drawdown based on Range of Possible One-Year EWA Asset Acquisition	5 to 17 feet
Normal Year Seasonal Fluctuations	2-3 feet (unconfined) 2 – 5 feet (semi-confined – confined)
Drought Year Seasonal Fluctuations	4-10 feet (unconfined) 4-16 feet (semi-confined and confined)

Source for groundwater level fluctuations: DWR Northern District 2002

As shown in Table 6-19, the potential groundwater level declines resulting from EWA Project Agency acquisitions would range from 5 to 17 feet in addition to seasonal fluctuation. Potential declines associated with the higher end of the EWA Project Agency acquisition range would be relatively large when compared to normal seasonal fluctuations, yet would be relatively close to the higher range of drought year seasonal fluctuations. The potential for adverse drawdown effects would be highest during the dry years when baseline fluctuations are already large and groundwater levels may be lower than normal. Groundwater levels would increase as the amount of extracted water increased. The potential may also increase if Anderson-Cottonwood ID is conducting groundwater substitution transfers in consecutive years and has experienced an annual net groundwater level decline.

Although groundwater drawdown may be less for the Fixed Purchase Alternative than for the Flexible Purchase Alternative, the types of potential adverse effects would be the same. Further discussions of these effects are provided in the Flexible Alternative discussion in Section 6.2.4.1.1 for the Redding Groundwater Basin.

As for the Flexible Purchase Alternative, the EWA Project Agencies would not make purchases that interfere or conflict with the local management efforts described in Section 6.2.4.1.1 and would not purchase water from an agency unless that agency had successfully complied with the groundwater mitigation measures. Therefore, for Anderson-Cottonwood ID to conduct an EWA transfer via groundwater substitution, the agency would have to implement the well review, access the need for a pre-purchase evaluation, and establish monitoring and mitigation measures outlined in the groundwater mitigation measures. *Consequently, EWA groundwater substitution transfers in the Redding groundwater subbasin could have potentially significant effects on groundwater levels, groundwater quality, surface water, and land subsidence. However, the groundwater transfers will be conducted in accordance with local management requirements and EWA groundwater mitigation measures (as discussed in Section 6.2.7) that will reduce these impacts to less than significant.*

6.2.5.1.2 Sacramento Groundwater Basin Crop Idling (Fallowing)

EWA acquisition of Sacramento River contractor water via crop idling of rice could decrease applied water recharge to the local groundwater system underlying the barren (idled) fields. Specific potential effects would be a decline in groundwater levels.

Figure 6-21 shows areas of rice production that could be idled in counties in the areas Upstream from the Delta Region. The assessment in this EIS/EIR limits EWA crop idling transfers to 20 percent of the amount of water that would have been applied in an agency for a given hydrologic year, based on economic considerations (Chapter 11). This would result in a loss of applied recharge to the Sacramento Groundwater Basin. However, this loss would be relatively small when compared to the total amount of water that recharges the Sacramento Groundwater Basin. A large portion of the total recharge to the basin is through precipitation and runoff over the spring and winter. As illustrated by the hydrographs on Figures 6-22 through 6-27, groundwater levels tend to generally recover during the rainy winter season. A 20 percent reduction in applied water recharge would be within the variability of annual recharge.

Furthermore, the land used for rice production consists of low permeable soils. A substantial portion of the applied water does not percolate to the underlying aquifer, but rather discharges to the farmer's surface drainage system. A reduction in applied recharge because of idled rice fields could have an effect on groundwater recharge and levels; however, the idling of rice fields would probably not substantially reduce the percentage of applied water that recharges the underlying Basin. *Consequently, the reduction in groundwater recharge as a result of rice idling would be less than significant.*

<u>Colusa Groundwater Subbasin Groundwater Substitution</u>

EWA Project Agency acquisition of Sacramento Contractor water in the Colusa groundwater subbasin via groundwater substitution could affect groundwater hydrology. The potential effects would be decline in groundwater levels, interaction with surface water, land subsidence, and water quality impacts. Groundwater substitution would most likely be concentrated in Glenn-Colusa ID and Reclamation District 108 (RD 108).

Groundwater substitution for EWA asset acquisition could result in temporary drawdown that exceeds historical seasonal fluctuations. (See the Colusa Subbasin discussion in Section 6.2.4.1.2 for more details on historical groundwater level fluctuations.) Table 6-20 compares the estimated potential drawdown resulting from a one-year EWA transfer with historical fluctuations for the Glenn-Colusa ID and RD 108. (The acquisition range and consequently the drawdown for RD 108 are the same as the Flexible Purchase Alternative shown in Table 6-8). Figure 6-22 shows the areas for which the regional declines are estimated**.** These areas were selected based on the wells used for the 2001 Forbearance Agreement transfer. Groundwater substitution pumping within Glenn Colusa ID was allocated proportionally according to the number of wells in each area – north, central, and south. The majority of the wells are concentrated in the northern part of the district.

Table 6-20
Fixed Alternative Estimate of the Groundwater Drawdown for Glenn-Colusa and Reclamation District 108

	Reclamation District 108	**Glenn Colusa ID**		
EWA Acquisition Range	5 TAF	20-35 TAF		
Estimated Regional Drawdown based on Range of Possible One-Year EWA Asset Acquisition (feet)	3	North area	Central area	South area
		3 to 6	1 to 2	Up to 1
Normal Year Fluctuations	2 to 5 feet (unconfined) 6-12 feet (semi-confined)	1 to 6 feet (unconfined) 2-20 feet (confined)		
Drought Year Fluctuations:	8-12 feet (unconfined)	2 to 12 feet (unconfined) 3-30 feet (confined)		

Source for annual fluctuations: DWR 2001

As shown in Table 6-20, the potential groundwater level declines resulting from the EWA acquisitions would range from one to six feet in addition to seasonal fluctuation. The magnitude of this potential drawdown is within the range of seasonal fluctuations. According to well data for Glenn Colusa ID (Table 6-9), 60 percent of the district's domestic wells and 10 percent of their agricultural wells are 110 feet deep, or shallower. It is unlikely that the transfers would result in a substantial regional effect to existing wells. Increased groundwater pumping could also cause localized declines in groundwater levels, or cones of depression, near pumping wells. These declines could be larger than those indicated in Table 6-20, possibly causing effects to wells within the cone of depression.

Although the potential maximum acquisition amount for Glenn Colusa ID differs between the Fixed and Flexible Purchase Alternatives by 60,000 to 35,000 acre-feet, the kinds of potential adverse effects would be the same. Past groundwater transfers, groundwater/surface water interaction, land subsidence, groundwater quality, and local groundwater management are discussed further in the Flexible Purchase Alternative, Section 6.2.4.1.1.

As for the Flexible Purchase Alternative, the EWA Project Agencies would not make purchases that interfere or conflict with the local management efforts described in Section 6.2.4.1.2 and would not purchase water from an agency unless that agency had successfully complied with the groundwater mitigation measures. Therefore, Glenn Colusa ID and RD 108 shall implement the well review, monitoring, and mitigation measures outlined in the groundwater mitigation measures before they conduct an EWA transfer via groundwater substitution. *Consequently, EWA groundwater substitution transfers conducted in the Colusa groundwater subbasin could have potentially significant effects on groundwater levels, groundwater quality, surface water, and land subsidence. However, the groundwater transfers will be conducted in accordance with local management requirements and EWA groundwater mitigation measures (as discussed in Section 6.2.7) that will reduce these impacts to less than significant.*

<u>East Butte and West Butte Groundwater Subbasins Groundwater Substitution</u>

EWA acquisition of Feather River Contractor water in the East Butte and West Butte groundwater subbasins via groundwater substitution could affect groundwater hydrology. The potential effects could be decline in groundwater levels, interaction with surface water, land subsidence, and water quality impacts. EWA groundwater substitution would be concentrated in the Joint Water Districts and Western Canal WD.

Groundwater substitution for EWA asset acquisition could result in temporary drawdown that exceeds historical seasonal fluctuations. (See the Colusa Subbasin discussion in Section 6.2.4.1.2 for more details on historical groundwater level fluctuations.) Table 6-21 compares the estimated potential drawdown as a result of a single year EWA-related groundwater transfer with historical fluctuations. Figure 6-23 shows the areas for which the regional declines are calculated. In the East Butte subbasin, groundwater has been extracted from throughout the districts; consequently, this analysis used areas within the districts' boundaries to estimate drawdown.

Table 6-21
Fixed Alternative Estimate of Groundwater Drawdown for the Butte Subbasins

	West Butte Subbasin	East Butte Subbasin	
EWA Acquisition Range	Western Canal – 10-35 TAF[1]	Joint Water Districts – 20-60 TAF[2] Western Canal WD – 10-35 TAF[1]	
Estimated Regional Drawdown based on Range of Possible One-Year EWA Asset Acquisition	Western Canal WD – 3 to 10 feet	Joint Water Districts – 3 to 8 feet Western Canal WD – 3 to 10 feet	
Normal Year Fluctuations	15 - 25 feet (semi-confined, confined)	North 15 feet (composite wells[3])	South 4 feet (composite wells) 4 feet (confined and semi-confined)
Drought Year Fluctuations	Up to 30 feet (semi-confined, confined)	North 30 -40 feet (composite wells[1])	South 10 feet (composite wells) 5 feet (confined and semi-confined)

Source of the normal and drought year fluctuations: DWR 2002

1 This acquisition range applies to the entire Western Canal WD, both in the West and East Butte subbasin.

2 This estimate assumes that 75 percent of the acquisition range of 20-60 TAF is allotted to the three of the Joint Water Districts, Biggs-West Gridley, Richvale, and Butte WD in the East Butte subbasin. The remaining 25 percent is allotted to Sutter Extension WD in the Sutter subbasin. This partitioning was based on the density of potential pumping wells in each subbasin.

3 Composite wells represent groundwater fluctuations that combine confined and unconfined portions of an aquifer

As shown in Table 6-21, the potential regional groundwater level declines resulting from an EWA-related transfer may cause an additional 3 to 10-foot decline in the Butte subbasins. This would not be a substantial decline when compared with the normal and drought year fluctuations for the northern portions of the subbasins. The selling agencies could experience regional declines of up to 10 feet, which could exceed normal year fluctuations in the southern portion of the subbasins. The potential for adverse drawdown effects would increase as the amount of extracted water increased. The potential for adverse effects would be higher still during dry years, when baseline fluctuations are already large and groundwater levels may be low.

Although there are exceptions,[17] the Joint Water Districts' members and Western Canal WD rely primarily on surface water diverted from the Feather River. During normal years, groundwater transfers would be less likely to affect wells throughout the majority of the districts because local users rely extensively on surface water. During dry years, however, DWR has the option to reduce supplies to the Joint Water

17 Such an exception is a portion of the Richvale ID service area, just west of Biggs and adjacent to the Butte Creek and Cherokee Canal. This area does not receive SWP allocation, but relies on groundwater and drainage water.

Districts.[18] Table 6-12 shows the number of wells within each district and the average depth of wells. Wells within the potential sellers' districts are relatively shallow. During dry years, groundwater may be an important supplement to surface water in some areas, and additional declines caused by groundwater substitution transfers would be more likely to result in adverse effects. Increased groundwater pumping could also cause localized declines of groundwater levels, or cones of depression near pumping wells. These declines are likely to be larger than those indicated in Table 6-11, possibly causing effects to wells within the cone of depression.

Although the potential maximum acquisition amount for the Joint Water Districts differs between the Fixed and Flexible Purchase Alternatives by 35,000 to 60,000 acre-feet the kinds of potential adverse effects are the same. Additional information on past groundwater transfers, groundwater/surface water interaction, groundwater quality, land subsidence, and local management are provided in the East Butte and West Butte Groundwater Subbasins discussion in Section 6.2.4.1.2.

Similar to the Flexible Purchase Alternative, the EWA Project Agencies would not purchase water from an agency unless the agency has successfully complied with the groundwater mitigation measures. Therefore, in order for Biggs-West Gridley WD, Richvale ID, Butte WD, and Western Canal WD to conduct an EWA transfer via groundwater substitution, the selling agencies would have to evaluate the need for a pre-purchase evaluation and implement the well review, monitoring, and mitigation measures outlined in the groundwater mitigation measures. *Consequently, EWA groundwater substitution transfers in the East Butte and West Butte groundwater subbasins could have potentially significant effects on groundwater levels, groundwater quality, surface water, and land subsidence. However, the groundwater transfers will be conducted in accordance with local management requirements and EWA groundwater mitigation measures (as discussed in Section 6.2.7) that will reduce these impacts to less than significant.*

East Sutter Groundwater Subbasin Groundwater Substitution

EWA acquisition of Feather River Contractor water in the East Sutter groundwater subbasin via groundwater substitution would affect groundwater hydrology. The potential effects would be decline in groundwater levels, interaction with surface water, land subsidence, and water quality impacts. EWA groundwater substitution would be concentrated in Sutter Extension ID and Garden Highway MWC.

Groundwater substitution under the Fixed Purchase Alternative could result in temporary drawdown that exceeds historical seasonal fluctuations. The potential drawdown as a result of an EWA-related groundwater transfer for Sutter Extension WD and Garden Highway is estimated to be between 3 to 6 feet and 22 feet,

[18] The Joint Water District administers 630,000 acre-feet of Feather River water to its member agencies, including Biggs-West Gridley WD, Butte WD, Richvale ID, and Sutter Extension ID. The Board controls, maintains, and operates the joint water distribution facilities for each district but does not own any production wells.

respectively. (See Figure 6-24 for the acquisition areas.) These estimates are based on the assumption for the Fixed Purchase Alternative acquisitions of 8,750 TAF[19] and 3 TAF for Sutter Extension WD and Garden Highway MWC, respectively. (The acquisition range and consequently the estimated regional drawdown for Garden Highway MWC is the same for both the Fixed and Flexible Purchase Alternative.) This drawdown could adversely affect local wells; however, there are insufficient data to determine typical regional groundwater level fluctuations. Increased groundwater pumping could also cause localized declines of groundwater levels, or cones of depression, near pumping wells. These declines would likely be larger than the regional declines, possibly causing effects to wells within the cones of depression.

Although the potential maximum acquisition amount for Sutter Extension differs between the Fixed and Flexible Purchase Alternatives, the kinds of potential adverse effects are the same. Additional information on past groundwater transfers, groundwater/surface water interaction, groundwater quality, land subsidence, and local management are provided in the East Sutter Groundwater Subbasin discussion in Section 6.2.4.1.2.

As for the Flexible Purchase Alternative, the EWA Project Agencies would not purchase water from an agency unless the agency has successfully complied with the groundwater mitigation measures. Therefore, in order for Sutter Extension WD and Garden Highway MWC to conduct a transfer to the EWA Program via groundwater substitution, these selling agencies would evaluate the need to conduct a pre-purchase evaluation and implement the well review, monitoring, and mitigation measures outlined in the groundwater mitigation measures. *Consequently, EWA groundwater substitution transfers in the East Sutter groundwater subbasin could have potentially significant effects on groundwater levels, groundwater quality, surface water, and land subsidence. However, the groundwater transfers will be conducted in accordance with local management requirements and EWA groundwater mitigation measures (as discussed in Section 6.2.7) that will reduce these impacts to less than significant*.

---

19 Sutter Extension is a member of the Joint Water Districts, which also includes Richvale ID, Butte WD, and Biggs-West Gridley WD. The 8,750 acre-feet acquired by Sutter Extension is one-fourth of the total 35,000 acre-foot acquisition amount that may be acquired by the Joint Board for the Fixed Purchase Alternative.

North and South Yuba Groundwater Subbasins

EWA acquisition of water from Yuba County Water Agency by groundwater substitution in the North Yuba and South Yuba groundwater subbasins could affect groundwater hydrology. The potential effects would be decline in groundwater levels, interaction with surface water, land subsidence, and water quality impacts . Groundwater substitution would be concentrated in the Yuba County Water Agency (WA) member agencies of Browns Valley ID, Brophy WD, Ramirez WD, Hallwood Irrigation Company, South Yuba WD, Dry Creek MWC, and Cordua ID.

EWA groundwater substitution transfers could result in groundwater level declines in excess of seasonal variation and these effects could be potentially significant. a. However, both subbasins demonstrate relatively quick recovery rates, indicating that they are not in overdraft and an EWA single year asset transfer would likely have a minimal effect on long-term groundwater level trends. However, multi-year groundwater transfers would increase the potential for adverse groundwater effects. Groundwater levels in portions of the North Yuba subbasin did not fully recover by the following spring after the 1991 State Drought Water Bank transfer. See North Yuba and South Yuba Groundwater Subbasins in Section 6.2.4.1.2 for further details on historical long-term groundwater level fluctuations.

Groundwater substitution under the Fixed Purchase Alternative could result in temporary groundwater drawdown that exceeds seasonal fluctuations. Estimates of potential regional drawdown caused by an EWA groundwater transfer could be 8 feet for both the North Yuba and South Yuba subbasins. Figure 6-25 shows the areas for which these regional declines were calculated**.** These areas were selected based on the use of wells for previous transfers to the EWA Project Agencies in 2001 and 2002. The estimate assumes that the North Yuba and South Yuba subbasins would each pump half the total 35 TAF acquisition amount.

Extraction from the South Yuba subbasin would be less likely to cause adverse effects than extraction from other areas, because the potential declines would be within the range of historical fluctuations. Because drawdown would affect shallow wells before deeper wells, the potential for adverse drawdown effects is greater in areas with more shallow wells.

Increased groundwater pumping could also cause localized declines of groundwater levels, or the development of cones of depression near pumping wells. To address these potential local declines, DWR and Yuba County WA implemented a cooperative monitoring program during Yuba County WA's groundwater substitution transfers to the EWA Project Agencies in 2001 and 2002.

Although the potential maximum acquisition amount of 35,000 acre-feet for the Fixed Purchase Alternative is less than the maximum amount of 85,000 acre-feet for the Flexible Purchase Alternative, the kinds of potential adverse effects would be the same. Additional information on past groundwater transfers, groundwater/surface water interaction, groundwater quality, land subsidence, and local management are provided in the Yuba Groundwater Subbasins discussion in Section 6.2.4.1.2.

As for the Flexible Purchase Alternative, the EWA Project Agencies would not purchase water from an agency unless the agency has successfully complied with the groundwater mitigation measures. Therefore, before the Yuba County WA or its member agencies conduct a transfer to the EWA Program via groundwater substitution, the Yuba County WA and/or its member agencies should evaluate whether it is necessary to conduct a pre-purchase evaluation and implement the well review, monitoring, and mitigation measures outlined in the groundwater mitigation measures. *Consequently, EWA groundwater substitution transfers in the North Yuba and South Yuba groundwater subbasins could have potentially significant effects on groundwater levels, groundwater quality, surface water, and land subsidence. However, the groundwater transfers will be conducted in accordance with local management requirements and EWA groundwater mitigation measures (as discussed in Section 6.2.7) that will reduce these impacts to less than significant*.

<u>North American (River) Groundwater Subbasin Groundwater Substitution</u>

EWA acquisition of American and Sacramento River water in the North American groundwater subbasin via groundwater substitution would affect groundwater hydrology. The potential effects would be decline in groundwater levels, interaction with surface water, land subsidence, and water quality effects. Groundwater substitution would most likely be concentrated in Natomas Central Mutual Water Company.

Groundwater substitution could result in temporary declines of groundwater levels. Historical groundwater level fluctuations in the North American subbasin vary. The underlying aquifer has a relatively short recovery period, and an EWA-related transfer would likely have a minimal effect on long-term groundwater level trends. See the North American (River) Groundwater Subbasin Groundwater Substitution in Section 6.2.4.1.2 for further details on historical long-term groundwater level fluctuations.

Groundwater substitution involving EWA asset acquisitions could result in temporary drawdown that exceeds historical seasonal fluctuations. The groundwater substitution acquisition ranges for both the Fixed and Flexible Purchase Alternatives would be the same. Consequently, the regional drawdown estimates and kinds of potential adverse effects for the Fixed Purchase Alternative would be the same as for the Flexible Purchase Alternative. Information on groundwater level effects, past transfers, groundwater/surface water interaction, land subsidence, groundwater quality, and local management are provided in North American (River) Groundwater Subbasin Groundwater Substitution discussion in Section 6.2.4.1.2.

As for the Flexible Purchase Alternative, the EWA Project Agencies would not purchase water from an agency unless the agency has successfully complied with the groundwater mitigation measures. Therefore, in order for Natomas Central MWC to conduct a groundwater substitution transfer with the EWA Program, Natomas Central MWC should evaluate whether it needs to conduct a pre-purchase evaluation and implement the well review, monitoring, and mitigation measures outlined in the groundwater mitigation measures. *Consequently, EWA groundwater substitution transfers in the North American (River) groundwater subbasin could have potentially significant effects on groundwater levels, groundwater quality, surface water, and land subsidence. However, the groundwater transfers will be conducted in accordance with local management requirements and EWA groundwater mitigation measures (as discussed in Section 6.2.7) that will reduce these impacts to less than significant.*

<u>North American (River) Groundwater Subbasin Groundwater Purchase</u>

EWA acquisition of American River water in the North American groundwater subbasin via groundwater purchase would affect groundwater hydrology. The potential effects would be decline in groundwater levels, interaction with surface water, land subsidence, and water quality effects. EWA groundwater transfers would most likely be managed by the Sacramento Groundwater Authority (SGA) and concentrated in the City of Sacramento, Fair Oaks Water District, and Citrus Heights Water District.

As described in the North American (River) Groundwater Subbasin Groundwater Purchase in Section 6.2.4.1.2, SGA manages the groundwater underlying the North Area, where the EWA Program may purchase groundwater. This area has historically been overdrafted. (See Section 6.2.4.1.2 for more details.) As a result of the WFA, groundwater extraction in the SGA's management area are not to exceed the defined sustainable yield of 131,000 acre-feet (EDAW and SWRI 1999). Any EWA-related groundwater extraction would also be subject to this limit and consequently, EWA transfers could not contribute to the exceedance of the sustainable yield.

Groundwater purchases involving EWA asset acquisitions could result in temporary drawdown that exceeds seasonal fluctuations. The groundwater purchase acquisition ranges for both the Fixed and Flexible Purchase Alternatives would be the same. Consequently, the regional drawdown estimates and potential adverse effects for the Fixed Purchase Alternative would be the same as for the Flexible Purchase Alternative. Information on groundwater level effects, past transfers, groundwater/surface water interaction, land subsidence, groundwater quality, and local management are provided in North American (River) Groundwater Subbasin Groundwater Purchase discussion in Section 6.2.4.1.2.

As for the Flexible Purchase Alternative, the EWA Project Agencies would not purchase water from an agency unless the agency has successfully complied with the groundwater mitigation measures. Therefore, in order for the SGA to conduct a groundwater purchase transfer with the EWA Program, SGA should evaluate the need to conduct a pre-purchase evaluation and implement the well review, monitoring, and mitigation measures outlined in the groundwater mitigation measures.

Consequently, EWA groundwater purchase transfers in the North American (River) groundwater subbasin could have potentially significant effects on groundwater levels, groundwater quality, surface water, and land subsidence. However, the groundwater transfers will be conducted in accordance with local management requirements and EWA groundwater mitigation measures (as discussed in Section 6.2.7) that will reduce these impacts to less than significant.

6.2.5.1.3 North San Joaquin Groundwater Basin

North San Joaquin Groundwater Basin Crop Idling

EWA acquisition of water via the idling of cotton crops would decrease applied water recharge to the local groundwater system underlying the barren (idled) fields. Specific potential effects could be a decline in groundwater levels.

Figure 6-28 shows the areas that could be idled in both the North San Joaquin and South San Joaquin Groundwater Basins. The acquisition amounts for the Flexible Purchase and Fixed Purchase would be the same, and the potential for adverse effects for both alternatives is minimal. (See North San Joaquin Groundwater Basin Crop Idling in Section 6.2.4.1.3 for more details.) The p*otential for reduction in groundwater recharge associated with the idling of cotton in the North and South San Joaquin Groundwater Basins would be less than significant.*

Merced River Contractor Groundwater Substitution

EWA acquisition of Merced River Contractor water via groundwater purchase would affect groundwater hydrology. Specific potential effects would be decline in groundwater levels, decrease of water levels in neighboring surface water channels including the Merced River, increased potential for land subsidence, and degradation of groundwater quality.

The groundwater acquisition ranges for both the Fixed and Flexible Purchase Alternatives would be the same for the Merced subbasin. Consequently, the regional drawdown estimates and kinds of potential adverse effects for the Fixed Purchase Alternative would be the same as for the Flexible Purchase Alternative. Section 6.2.4.2.3, Merced River Contractor Groundwater Substitution , provides information on groundwater level effects, past transfers, groundwater quality effects, land subsidence effects, and local management.

Similar to the Flexible Purchase Alternative, the EWA Project Agencies would not purchase water from an agency unless the agency has successfully complied with the groundwater mitigation measures. Therefore, to conduct an EWA groundwater purchase transfer, Merced ID would have to evaluate whether a pre-purchase evaluation needs to be conducted and implement the well review, monitoring, and mitigation measures outlined in the groundwater mitigation measures. *Consequently, EWA groundwater substitution transfers of Merced River Contractor groundwater in the North San Joaquin groundwater basin could have potentially significant effects on* *groundwater levels, groundwater quality, surface water, and land subsidence. However, the groundwater transfers will be conducted in accordance with local management requirements and EWA groundwater mitigation measures (as discussed in Section 6.2.7) that will reduce these impacts to less than significant.*

6.2.5.2 Export Service Area

EWA acquisitions that could affect groundwater resources in the Export Service Area include crop idling, groundwater purchase, and groundwater storage. The effects associated with these acquisitions include groundwater level declines, alteration of surface and groundwater hydrology, land subsidence, and changes in groundwater quality.

6.2.5.2.1 South San Joaquin Groundwater Basin Crop Idling

EWA acquisition of water via cotton crop idling would decrease applied water recharge to the local groundwater system underlying the barren (idled) fields. Specific potential effects would be a decline in groundwater levels.

Figure 6-28 shows the areas that could be idled in both the North San Joaquin and South San Joaquin Groundwater Basins. The acquisition amounts for the Flexible Purchase and Fixed Purchase Alternatives would be the same, and the potential for adverse effects for both alternatives is minimal. (See North San Joaquin Groundwater Basin Crop Idling in Section 6.2.4.1.3 for more details.) *Potential groundwater impacts associated with the idling of cotton in the North and South San Joaquin Groundwater Basins would be less than significant.*

6.2.5.2.2 South San Joaquin Groundwater Basin Banked Groundwater

EWA acquisition of banked groundwater from water bank participating agencies in Kern County, via groundwater purchase and recovery through direct extraction from the banking facilities, could decrease groundwater levels. Specific potential effects would be declines in groundwater levels, increased potential for land subsidence, degradation of groundwater quality, and the reduction of banked groundwater available for future transfers.

The groundwater acquisition ranges for both the Fixed and Flexible Purchase Alternatives would be the same for the South San Joaquin Groundwater Basin (Kern subbasin). Consequently, the regional drawdown estimates and potential adverse effects for the Fixed Purchase Alternative would be the same as for the Flexible Purchase Alternative. Information on groundwater levels, past transfers, groundwater quality effects, land subsidence effects, the multi-year acquisitions and the reduction in available banked groundwater, and local management are provided in the South San Joaquin Groundwater Basin Banked Groundwater discussion in Section 6.2.42.

Operations of the Kern County groundwater banks (by the owners/sponsors in Table 6-3) must adhere to the MOUs and Agreements (Table 6-17) signed by these participating agencies. Groundwater transfers to the EWA Project Agencies must not only meet the approval of Kern County WA, but must also gain the approval of the banking participants and meet the operational criteria set forth by the MOUs and agreements. These MOUs and agreements specify operational parameters and priorities for participating entities, monitoring requirements, and mitigation strategies.

In addition to the MOUs and Agreements, current Kern County WA policy may place limitations on the sale of banked water from the SWP, and there are further limitations on potential sales of Friant-Kern (CVP) water. A place-of-use restriction requires banked Friant-Kern water to be used within county limits. Consequently, these agreements legally limit the classification of water that may be sold to the EWA Project Agencies. The acquisition of banked groundwater for consecutive years may reduce the amount of banked groundwater available to the EWA Program in following years. Ongoing discussion concerns whether the limitation on selling water from the SWP could be changed.

Consequently, potential impacts associated with the groundwater purchase and direct recovery operations conducted in accordance with local groundwater management requirements for the EWA Program would be less than significant.

6.2.5.2.3 South San Joaquin Groundwater Basin Groundwater Storage

Groundwater storage of EWA acquisition water in Semitropic WSD or Arvin-Edison WSD's groundwater banking facilities would change groundwater levels. This could result in potential adverse impacts generally associated with groundwater banking facilities, including groundwater level declines when groundwater is extracted, land subsidence, and groundwater quality degradation.

The Kern County WA groundwater purchase effects assessment above discusses potential effects in both Semitropic WSD and Arvin-Edison WSD. The storage of EWA water would result in the same potential effects. As shown in Table 6-17, Semitropic WSD and Arvin-Edison WSD currently have established MOUs/agreements with participating banking and adjoining agencies. It is anticipated that if the EWA becomes an active banking participant (storing EWA water) in either Arvin-Edison WSD or Semitropic WSD, the EWA Program would also have an operating agreement or MOU that would address potential adverse effects. These agreements would address the mitigation of potential adverse effects generally associated with groundwater banking activities, including periodic groundwater level declines caused by groundwater extraction, land subsidence, and groundwater quality degradation. *Consequently, for groundwater transfers conducted in accordance with local management, the potential groundwater impacts would be less than significant.*

Groundwater storage of EWA acquisition water in Semitropic WSD or Arvin-Edison WSD's groundwater banking facilities could change groundwater levels and would provide benefits.

As previously discussed, groundwater resources in Semitropic WSD and Arvin-Edison WSD have historically experienced overdraft conditions. Although groundwater levels have increased since the beginning of banking operations (Figure 6-30), a large amount storage of capacity is available in the underlying aquifer. The purchase of storage space for groundwater banking of EWA water (used to recharge the underlying aquifer) would increase the EWA Project Agencies' operational flexibility. The banked EWA water would also benefit Semitropic WSD and Arvin-Edison WSD by increasing groundwater levels in their underlying basins.

6.2.6 Comparative Analysis of Alternatives

The Fixed Purchase and Flexible Purchases Analyses identified the potential groundwater effects of water transfers from the proposed selling agencies listed in Tables 2-5 and 2-9. Additional information was provided on groundwater management within the local selling agencies and explanations on how the groundwater mitigation measures help to assure that effects are minimized. Including all potential transfers ensures that the analysis identifies effects for these transfers and provides the EWA agencies the flexibility to choose transfers that may be preferable in a given year. Table 6-22 provides a comparative summary of both action alternatives. EWA operations would most likely differ annually, depending on year type, and the EWA agencies would not purchase all available storage and management options in every year. This section discusses how the EWA agencies would actually operate the program in different year types, and reflects a more realistic view of what effects would occur in these years.

In the No Action/No Project Alternative, farmers would change some practices depending on the water year type. In wet years, surface water supplies would be plentiful and farmers would most likely irrigate with those supplies (in areas with water rights or contracts). In dry years, most areas with water rights or contracts would experience some reduction in surface water supplies. Farmers would then change practices to handle this reduction, often switching to groundwater supplies and occasionally idling crops. As discussed in the above sections, local water users utilize increased amounts of groundwater during dry years.

6.2.6.1 Upstream from the Delta Region

The Fixed Purchase Alternative would be limited to a maximum acquisition of 35,000 acre-feet from all sources of water. In most years, this amount could be obtained as surface water stored in non-Project reservoirs. The Fixed Purchase Alternative would not likely involve acquisition of groundwater and, thus, would have no effect on groundwater resources. In years in which surface water assets are not available (in part or in total), the EWA Project Agencies would acquire water next through groundwater substitution and/or groundwater purchase, then by crop idling. Because surface water acquisition would be the focus of the Fixed Purchase Alternative, it would be unlikely that the EWA Program would acquire water through

Table 6-22
Groundwater Effects for the Flexible and Fixed Purchase Alternatives Compared to the Baseline Condition

Region	*Asset Acquisition*	*Result*	*Potential Effects*	*Flexible Purchase Alternative Change from Baseline*	*Fixed Purchase Alternative Change from Baseline*	*Significance of Flexible Purchase Alternative After Mitigation*	*Significance of Fixed Purchase Alternative After Mitigation*	*Comments*
Upstream from the Delta Region	Crop Idling Flex: 295 TAF[1] Fixed: 35 TAF	Decrease applied water recharge to the local groundwater system.	Decline in groundwater levels.	Reduction of applied recharge of up to 295 TAF.	Reduction of applied recharge of up to 35 TAF.	PS;LTS with mitigation measures	PS; LTS with mitigation measures	Declines in groundwater levels would be minimal.
	Groundwater Substitution Flex: 315 TAF[2] Fixed: 35 TAF	Groundwater is used in place of surface water.	Groundwater level declines, decrease of water levels in neighboring surface water channels, increased potential for land subsidence and degradation of groundwater quality.	Would vary given site-specific conditions and level of pumping.	Would vary given site-specific conditions and level of pumping.	PS; LTS with mitigation measures	PS; LTS with mitigation measures	Local management and monitoring, in addition to the groundwater mitigation measures, provide assurances that all impacts would be monitored and mitigated to less than significant on a local level.
	Stored groundwater purchase Flex: 10 TAF Fixed: 10 TAF	Extraction of water from groundwater storage.	Groundwater level declines, decrease of water levels in neighboring surface water channels, increased potential for land subsidence, and degradation of groundwater quality.	Would vary given site-specific conditions and level of pumping. Potential for adverse effects would increase during dry years.	Would vary given site-specific conditions and level of pumping. Potential for adverse effects would increase during dry years.	PS; LTS with mitigation measures	PS; LTS with mitigation measures	Local management and monitoring, in addition to the EWA groundwater mitigation measures, provide assurances that all impacts would be monitored and mitigated to less than significant on a local level.
Export Service Area	Crop Idling Flex: 420 TAF Fixed: 150 TAF	Decrease applied water recharge to the local groundwater system underlying the barren fields.	Possible increase in soil salinity and groundwater levels under perched conditions or a decline in groundwater levels	Reduction of applied recharge of up to 420 TAF.	Reduction of applied recharge of up to 150 TAF.	PS; LTS with mitigation measures	PS; LTS with mitigation measures	Declines in groundwater levels would be minimal.
	Groundwater Substitution Flex: 25 TAF Fixed: 25 TAF	Groundwater is used in place of surface water.	Groundwater level declines, decrease of water levels in neighboring surface water channels, increased potential for land subsidence, and degradation of groundwater quality.	Would vary given site-specific conditions and level of pumping.	Would vary given site-specific conditions and level of pumping.	PS; LTS with mitigation measures	PS; LTS with mitigation measures	Local management and monitoring, in addition to the groundwater mitigation measures, provide assurances that all impacts would be monitored and mitigated to less than significant on a local level.

Table 6-22
Groundwater Effects for the Flexible and Fixed Purchase Alternatives Compared to the Baseline Condition

Region	Asset Acquisition	Result	Potential Effects	Flexible Purchase Alternative Change from Baseline	Fixed Purchase Alternative Change from Baseline	Significance of Flexible Purchase Alternative After Mitigation	Significance of Fixed Purchase Alternative After Mitigation	Comments
	Stored Groundwater Purchase Flex: 150 TAF Fixed: 150 TAF	Extraction of water from groundwater storage.	Groundwater level declines, decrease of water levels in neighboring surface water channels, increased potential for land subsidence, and degradation of groundwater quality.	Would vary given site-specific conditions and level of pumping	Would vary given site-specific conditions and level of pumping	PS; LTS with mitigation measures	PS; LTS with mitigation measures	Local monitoring and other operational agreements provide assurances that all impacts would be monitored and mitigated to less than significant on a local level.
	Groundwater Storage Services Amount of water stored has not been determined	Storage of EWA acquired water in groundwater storage facilities	Increase in groundwater levels.	Amount of water stored has not been determined	Amount of water stored has not been determined	PS; LTS with mitigation measures	PS; LTS with mitigation measures	It is anticipated that NEPA/CEQA documentation and other operational agreements that would be developed between the EWA Project Agencies and the banking participants would provide assurances that all impacts are LTS or monitored and mitigated to less than significant on a local level.

PS = potentially significant LTS = less than significant
The asset acquisition amounts are not simply additive and do not necessarily represent what would occur in any given year.

[1] This value represents the reduction of applied recharge and differs from the values presented for crop idling in other chapters which represent the amount of water that would be available to the EWA and conveyed through the Delta. These values differ due to release limitations for Shasta Reservoir. Releases for the EWA Program to provide fishery protection are limited until after May. Consequently, the EWA Program may lose a portion of water acquired through crop idling.

[2] This value represents the amount of groundwater extracted for a groundwater substitution transfer and differs from the values presented for crop idling in other chapters which represent the amount of water that would be available to the EWA and conveyed through the Delta. These values differ due to release limitations for Shasta Reservoir. In order to provide fishery protection, releases for the EWA Program are limited until after May. Consequently, the EWA Program may lose a portion of water acquired through the groundwater substitution transfers.

groundwater substitution or purchase every year, and less likely that a groundwater transfers would occur for consecutive years in a given area. This alternative would not result in long-term groundwater effects.

The Flexible Purchase Alternative could involve the purchase of up to 600,000 acre-feet of water from all sources in areas Upstream from the Delta Region. If the EWA Project Agencies were to acquire 600,000 acre-feet in areas from the Upstream from the Delta Region, they would need to utilize most available sources, which would include stored reservoir water, groundwater substitution, groundwater purchase, and crop idling. The amount that could be purchased would be limited by the excess capacity of the Delta export pumps to move the water to export areas south of the Delta.

During wet years, pump capacity available for EWA asset water may be limited to as little as 50,000 – 60,000 acre-feet because the Projects would primarily use their pumps to deliver to their users in the Export Service Area. The potential for groundwater effects during wet years for the Flexible Purchase Alternative would be very similar to effects of the Fixed Purchase Alternative. Acquisitions would most likely be from stored surface water sources and not from groundwater sources, and there would be no groundwater effects.

The Flexible Purchase Alternative's greater reliance on groundwater substitution and purchase acquisitions during dry years would result in a greater potential for groundwater effects than with the Fixed Purchase Alternative. During dry years, when the Projects have less water available for pumping to users in the Export Service Area, the pumps would have greater available capacity for the EWA. The EWA Program would acquire up to 600,000 acre-feet from areas Upstream from the Delta Region; to reach this quantity, the EWA agencies would rely more on groundwater resources for the additional EWA acquisitions. The potential for groundwater effects could increase if multi-year groundwater transfers occur in the same area for a consecutive number of years. Also, the potential of adverse effects would increase if there were an annual net decline in groundwater levels or if there were several consecutive dry (drought) years when water users would rely more heavily on groundwater supplies. Implementing the groundwater mitigation measures would reduce the significance of these effects to less than significant.

6.2.6.2 Export Service Area

EWA asset acquisitions in the Export Service Area under the Fixed Purchase Alternative would be 150,000 acre-feet from stored groundwater and crop idling sources. The EWA Project Agencies would acquire stored groundwater only from agencies that have previously stored water in the ground (e.g., Kern Water Bank). As discussed in Section 6.2.4.2, the amount of water available for transfers outside of Kern County is limited. The purchase of banked groundwater for a consecutive number of years may reduce the amount of water available for future years.

EWA asset acquisitions in the Export Service Area under the Flexible Purchase Alternative would be dependent on the water year type north of the Delta. Export pump capacity during wet years would limit the ability of the EWA Project Agencies to move assets through the Delta, requiring reliance on greater purchase amounts from export area sources. During wet years, acquisitions within the Export Service Area could involve up to 540,000 acre-feet of assets assuming that quantity would be available from Export Service Area sources. Consecutive multi-year acquisitions exceeding the 150,000 acre-foot purchase cap for the Fixed Purchase Alternative would deplete groundwater reserves available for future transfers outside Kern County at a more rapid rate than the Fixed Purchase Alternative. The MOUs and agreements discussed in Sections 6.2.4.2 and 6.2.5.2 would minimize the adverse effects of these increased acquisitions and address any effects that occur.

6.2.7 Groundwater Mitigation Measures

The Purchasing Agencies Review Process and groundwater mitigation measures in Section 6.2.7.1 and Section 6.2.7.2 sets forth a framework that is designed to avoid adverse groundwater effects. The EWA agencies will adopt these mitigation measures to assure that EWA purchases do not result in significant, unmitigated adverse effects related to groundwater extraction. The EWA agencies have employed similar measures on other transfers, and are committed to implementing these measures for any groundwater-related actions. Alternative approaches to mitigation are possible and may be appropriate for water transfer projects that are undertaken by other parties and that are not part of the EWA.

6.2.7.1 EWA Project Agencies' Principles for Entering into Groundwater Based Transfers

Particular care is required to design groundwater transfers that would not have significant unmitigated effects on other users of water or have unacceptable environmental effects. In order to minimize the environmental effects of the EWA water acquisition program, the EWA agencies have developed mitigation measures to be applied prior to entering into any purchase that would involve the extraction of groundwater. The mitigation measures serve to limit the potential for significant injury to other legal users of water and effects on the environment. When negotiating water purchases, the Project Agencies would apply these mitigation measures to water acquisitions for the EWA. The mitigation measures do not represent the only viable approach to mitigation of potentially significant impacts that may result from groundwater substitution based transfers.

The following text describes the systematic process that the Project Agencies would follow when deciding whether to purchase water through groundwater based transfers. The objectives of this process are: to mitigate significant environmental effects that occur; to minimize potential effects to other legal users of water; to provide a process for review and response to reported third party effects; and to assure that a local mitigation strategy is in place prior to the groundwater transfer.

The process should be a collaborative effort between willing sellers and the Project Agencies. This process recognizes that the seller should be responsible for assessing and mitigating significant adverse effects resulting from the transfer within the source area of the transfer. It also recognizes that the EWA agencies' principles require them to determine whether the seller has an adequate mitigation plan in place. Accordingly, the Project Agencies would take on the responsibility of reviewing existing groundwater levels in the local area of transfer and approving the seller's extraction wells, monitoring, and mitigation plans prior to the initiation of a groundwater based transfer to the purchasing agencies. This review and approval process would be necessary to provide credibility to the determination by the EWA agencies that no significant environmental impacts would occur, while relying on the sellers for implementation of the local monitoring and mitigation programs.

6.2.7.1.1 Purchasing Agencies Review Process

Initially, the seller would submit the information set forth in the groundwater mitigation measures to DWR. (See Section 6.2.7.2, Information to be Submitted.) After receipt of this information, the following procedure would take place to evaluate the information provided:

- A Review Team, composed of DWR and Reclamation technical staff (that includes California Certified Hydrogeologists), would review and evaluate the information provided according to the objectives and specifications outlined in the mitigation measures. The review is intended to ensure that the wells used in the program would not pose an unacceptable risk of depleting surface water and that the seller has developed monitoring and mitigation programs necessary to recognize and avoid/mitigate for significant environmental and water user effects that could occur as a result of the groundwater transfer.

- If the Review Team concluded that the potential for effects would be relatively low and that the proposed transfers to the EWA would reasonably address mitigation of anticipated adverse effects, the process to initiate the transfer could commence. However, if modifications were necessary, the Review Team would provide recommendations to the seller regarding changes that should be made prior to the transfer in order for EWA to purchase the water proposed for transfer. The Review Team would work with the seller to identify appropriate means to address any changes to the submitted proposal to comply with the EWA purchasing principles.

- If agreement were reached on an acceptable project proposal, the Project Agencies and willing seller would negotiate a contract to implement the proposed transfer.

The Review Team would need sufficient information to evaluate whether the desired objectives are met. The mitigation measures provide recommendations on the information to be submitted for review.

The Review Team recognizes that site conditions vary agency-to-agency and the extent of information that needs to be submitted would differ. These recommendations would serve as an initial guideline to selling agencies concerning the level of detail and type of information that may be needed to evaluate the proposed well operations and programs for compatibility with the EWA purchasing principles. The Review Team may require additional information prior to project implementation, or additional studies during implementation, to verify the validity of the hydrogeologic analysis underlying the project proposal.

The primary objective of the Review Team would be to develop reasonable assurance that all significant groundwater effects that could result from groundwater transfers to the EWA Project Agencies have been identified, assessed, avoided where possible, and mitigated if avoidance were not possible.

6.2.7.2 Groundwater Mitigation Measures

The groundwater mitigation measures will apply to all EWA groundwater transfers with exception of those from established groundwater banks that have undergone environmental review (meeting CEQA/NEPA specifications) and have developed formal agreements/MOUs regarding banking operations among the banking participating agencies and if need be, among adjoining agencies. The mitigation measures consist of four components: Well Review, Pre-Purchase Groundwater Evaluation, Monitoring Program, and Mitigation Program. The sections below describe these measures.

6.2.7.2.1 Well Review

Objective: The purpose of the well review is to assure that all extraction wells used for water transfer to the EWA would be located and operated in such a manner as to minimize the potential risk of depleting surface water sources and adversely effecting groundwater quality. [20]

The well review will not be used to determine which wells can be used for private uses or independent transfers, but solely to determine whether the buyers would enter into a purchase agreement that includes the use of the proposed wells. If a well is found to be unacceptable for use in the proposed transfer, the Review Team and seller may, if desired by the seller, agree to develop additional information on the well(s) in question, conduct investigations to resolve the Review Team's concerns, adopt criteria for well operation, or develop a method for discounting the production of the well to reflect any agreed-upon depletion of surface water sources effected by the pumping. Regardless of the foregoing efforts, the seller will retain the sole discretion as to whether to accept the recommendations of the Review Team or to opt

[20] The well review in the EWA groundwater mitigation measures originated from the "Water Transfers Paper for Water Transfers in 2002 involving the Department of Water Resources" (DWR, 2002). These reviews are very similar, except that the EWA mitigation measures also addresses the degradation of water quality.

not to use the well(s) in question as part of the transfer to EWA. Following review of the well information (see description of information to be submitted below), the seller and Review Team will discuss proposed operational constraints. The seller will have the option of: (a) adhering to the proposed operational constraints, (b) conducting additional investigations to prove scientifically that the operation of the well(s) in question does not result in adverse effects, or (c) electing not to participate in the proposed transfer.

Information to be Submitted: The seller will submit a variety of information to the Review Team for the Well Review no less than one month in advance of the transfer. Well-specific data to be submitted to the Review Team includes:

1) Locations of proposed production wells and monitoring program wells plotted on USGS 7.5-minute quadrangle maps and listed in a table showing well owner, well name or owner's number, State Well Number (if known), and latitude and longitude.

2) A driller's log giving the geology and well construction details (well seals and well perforated intervals) or a letter from the drilling company giving this information. A geophysical log could be used in place of the geology on the driller's log. If the driller's log and the well construction details are not consistent, additional information may be required.

3) In the absence of the data outlined in item (2), other information, such as aquifer performance tests or other local studies, that characterizes the hydrogeologic environment near the well and allows evaluation of potential effect to nearby rivers, streams, canals or drains should be provided. In the absence of this information the Review Team may recommend additional monitoring/testing to develop the needed information while allowing interim use of the well.

The amount of information submitted for each well will depend on its location relative to surface water features and other areas that may be highly sensitive to effects. The criteria outlined below are intended to: 1) serve as a guideline for sellers on the extent of information that should be submitted to the Review Team and 2) indicate how the Review Team will perform the initial review of the wells within one to two miles of major surface water features and minor surface water features. For the Sacramento Valley these features are shown on the draft map entitled "Groundwater Substitution Water Transfers Well Approval Areas" dated January 18, 2002. In addition, any wetlands that have been formally delineated and that are dependent upon groundwater should be treated as minor surface water features.

Provided that wells are farther than two miles from major surface water features, farther than one mile from minor surface water features, and they do not appear to be located in areas that may result in additional effects mentioned above, the wells will be accepted for providing EWA assets.

Evaluation: Wells that have previously been determined to meet the well approval provisions of the mitigation measures may not need to be reviewed unless the Review Team decides that sufficient new information on the hydrogeology of the project area has been developed to merit reconsideration, or that the wells are located in proximity to an area of groundwater contamination that may be induced to migrate into previously uncontaminated areas. Sellers will be encouraged to discuss these matters with the Review Team prior to submitting well information.

The following acceptance criteria minimize the risk of harm to legal downstream water users and the potential for effects to the riverine environment.

<u>Wells between one and two miles</u> of a major surface water feature tributary to the Delta will be accepted unless one of the following applies:

- Insufficient information is submitted, that is, no driller's log or other sufficient information is submitted to demonstrate that the well is not connected to the surface water system tributary, or

- The well is perforated within 50 feet of the ground surface and the information submitted is insufficient to demonstrate that the well is not connected to the surface water system tributary to the Delta.

<u>Wells within one mile or less</u> of a major surface water feature tributary to the Delta will be accepted if the following conditions are met:

- The uppermost perforations start below 150 feet bgs; or

- The uppermost perforations start between 100 and 150 feet bgs and the well has a surface annular seal to at least 20 feet; a total of at least 50 percent fine-grained materials in the interval above 100 feet bgs; and at least one fine-grained layer that exceeds 40 feet in thickness in the interval above 100 feet bgs; or

- The seller provides other information to DWR and Reclamation that demonstrates that the well is not in connection with the surface water system tributary to the Delta.

<u>Wells near minor surface water features</u> tributary to the Delta that will be potentially affected by groundwater pumping will be evaluated by using the following procedure:

- Wells that are between one half and one mile from minor surface water features tributary to the Delta will be accepted using the same criteria listed for the wells that are between one and two miles from a major surface water feature above.

- Wells within one-half mile or less of a minor surface water feature tributary to the Delta will be approved using the same criteria listed for wells that are within one mile of a major surface water feature. If it can be determined that the minor surface water feature (other than a wetland) does not flow during times when the Sacramento-San Joaquin Delta is in balanced conditions, the wells will be acceptable regardless of construction characteristics.

6.2.7.2.2 Pre-Purchase Groundwater Evaluation

Objective: The purpose of the Pre-Purchase Groundwater Evaluation is to avoid groundwater transfers that could result in regionally significant adverse effects. Within the context of the groundwater mitigation measures, regional effects will apply to groundwater effects that are experienced in the majority or large portion of a selling agency's boundaries and may also affect adjoining districts. In contrast, local well interference effects from drawdown around wells would imply a much smaller scale. For instance, if it was demonstrated that the pumping activity for a transfer is adversely affecting several neighboring wells, this will be defined as a local effect.

The Pre-Purchase Groundwater Evaluation is intended to avoid effects resulting from water transfers that could occur in consecutive years or during extended dry periods. Local effects that could occur following EWA transfers are addressed in the remaining three components of the groundwater mitigation measures.

Evaluation and Information to be Submitted to the Review Team: Prior to an EWA groundwater acquisition, groundwater levels will be assessed relative to historical levels and the proposed transfer amount. The nature of a Pre-Purchase Evaluation will vary according to whether the selling agency overlies an overdrafted subbasin or a subbasin that typically recovers either during the subsequent wet season or during the wet period following a dry year or a series of dry years. Furthermore, the level of detail needed for an evaluation will also depend on the existing hydrologic conditions and the relative potential of regional effects.

Prior to the evaluation, the selling agency and the Review Team will discuss and agree on the level of the Pre-Purchase Evaluation. The following discussion provides general guidelines on the level of evaluation needed for subbasins that typically experience full recovery during the wet season (given the potential for regional effects) and for overdrafted subbasins.

Minimal Potential for Regional Effects in a Non Overdrafted Subbasin – If existing groundwater levels are high relative to historical fluctuations, then groundwater transfers will likely not have potentially adverse effects. Selling agencies should submit regional groundwater level data to the Review Team. A regional groundwater level review, however, will not be necessary. The transfer will be performed in accordance with the remaining elements of the groundwater mitigation measures.

Intermediate Potential for Regional Effects in a Non Overdrafted Subbasin – If existing groundwater levels are within the intermediate range of historical fluctuations, then a groundwater transfer could potentially cause levels to decline below historical levels.

The willing seller will complete a pre-purchase evaluation to further investigate the potential for adverse regional effects. This evaluation will consider the following: 1) groundwater level fluctuations for existing monitoring wells, 2) surface water imports and applied water recharge, 3) recent and historical hydrology 4) expected groundwater extraction activities from local farmers and other acquisition programs, and 5) any areas of special concern, such as localized areas of poor groundwater quality. Given the results of the study, the seller can choose the following: 1) modify recovery operations to avoid areas of higher risk, 2) decrease the amount transferred, or 3) carry forward with the proposed transfer if the willing seller concludes that potentially adverse effects would be minimal. The willing seller will submit the results of this evaluation, in addition to any operational modifications, to the Review Team. The Review Team will assess the results and determine whether they agree or require additional modifications to the extraction operations to avoid effects.

Elevated Potential for Regional Effects in a Non Overdrafted Subbasin - If existing groundwater levels are at the lower range of historical fluctuations, then a groundwater transfer will increase potential for causing the groundwater levels to fall below historic levels and cause regional adverse effects. The selling agency will have the option of conducting a pre-purchase evaluation, discussed above. If the Review Team, however, concludes that there is a high risk for significant regional adverse effects, the Project Agencies will not buy groundwater for the hydrologic year.

Potential of Regional Effects in an Overdrafted Subbasin – Selling agencies overlying an overdrafted subbasin must demonstrate that they have groundwater management strategies in place to manage the groundwater resources. These strategies can include groundwater management plans, groundwater recharge facilities, conjunctive use projects, groundwater conservation efforts, monitoring programs, or other components. The selling agency will submit a summary of these management strategies to the Review Team. In addition, the selling agency will make a formal determination that the proposed transfer will not contribute to conditions of long-term overdraft and that it is consistent with any applicable groundwater management plan. The Review Team will determine whether these management efforts are suitable to avoid regional effects or whether groundwater management modifications are needed to ensure that all effects are avoided. If necessary, the Review Team can also require an evaluation of existing groundwater levels, similar to the evaluation described in Intermediate Potential for Regional Effects in a Non Overdrafted Subbasin above. EWA transfers will only take place when the Review Team has concluded that the potential for all regional effects is minimal and that transfer amounts would not contribute to additional long-term drawdown.

6.2.7.2.3 Monitoring Program

Objective: Sellers transferring water to the EWA Project Agencies via groundwater transfers will demonstrate to the Review Team that they have an established Monitoring Program to identify potential effects before they become significant. The Monitoring Program:

- Provides assurances that the quantity of water pumped in lieu of surface deliveries is accounted for properly and is delivered to the EWA Project Agencies.
- Determines the surface water/groundwater interactions in the areas where groundwater is pumped for the transfer agreement, including both pumping-induced infiltration and interception of groundwater discharge or identification of a program that addresses this issue.
- Assesses the effects of the transfer on the existing groundwater system.
- Determines the direct effects of transfer pumping on the groundwater basin, including any residual effects until full recovery of pre-project water levels occurs or seasonal high levels occur in the spring following the transfer.
- Assesses the occurrence of any third party effects and, if they occur, their magnitude and significance.
- Coordinates the monitoring program, as appropriate, with other established programs in the area.

Evaluation: The regional extent and frequency of monitoring necessary to meet the program objectives will depend on site specific factors, such as the subsurface hydrogeology, local hydrology, and operation of the extraction pumps. For instance, areas that are susceptible to land subsidence may require extensometers, while areas with groundwater quality concerns may require a more comprehensive set of groundwater quality laboratory tests. The monitoring programs will be evaluated on their ability to meet the objectives outlined above relative to site-specific conditions within the affected area. To meet the objectives, a monitoring program will, at a minimum, contain the following components: 1) a network of monitoring wells that adequately covers the area that is to be pumped, 2) periodic flow meter readings at the extraction pumps, 3) periodic measurements of groundwater levels, 4) groundwater quality testing, 5) means to detect land subsidence or a credible analysis demonstrating that subsidence is unlikely to occur, and 6) a coordinated means to collect data and cooperate with other monitoring efforts in the area.

Information to be Submitted: Each seller will submit sufficient information documenting that its proposed transfer incorporates all of the elements listed above. The seller will submit the planned monitoring program to the Review Team at least one month prior to the groundwater transfer. The following discussion provides additional detail regarding the monitoring plan components and information that the seller needs to document.

*Monitoring Wells and Locations***:** The seller will provide evidence that it has developed the monitoring well network giving consideration to the location of production wells, the construction of both the monitoring and production wells, the location of third party wells and the relationship of production wells to surface water bodies and any contaminated areas that could be affected by pumping. This ensures that the Monitoring Program incorporates a sufficient number of monitoring wells to accurately characterize groundwater levels and response in the area before, during, and after transfer pumping takes place. Selling agencies will submit a map showing the location of the monitoring wells in relation to the extraction wells that would be used during the transfer.

Groundwater Pumping: The recording of flow meter readings will be performed upon initiation of pumping and at designated times during the duration of the transfer. The seller will calculate and report the quantity of water pumped between successive readings. In addition, the seller will record electric meter readings and fuel consumption for diesel pumps and make the records available to the Review Team for audit upon request.

Groundwater Levels. The selling agency will report measurements of groundwater levels in both production and monitoring wells to the Review Team. This reporting will include the frequency of readings prior to pumping to establish background trends. Reporting will also include measurements during the transfer, and, no less frequently than monthly following the termination of pumping, continue until water levels recover to pre-pumping levels or water levels recover to seasonal highs in the spring of the year following the transfer. The selling agencies will submit a proposed schedule of readings to the Review Team for initial review.

Groundwater Quality: The extent of groundwater quality monitoring needed to access effects will depend on the potential movement of water of reduced quality in response to transfer-related pumping. The extraction of groundwater from areas that are relatively close to reduced quality conditions can require more intensive monitoring than areas that have documented good water quality. Groundwater quality testing will incorporate electrical conductivity testing and be conducted at selected production and monitoring wells. Such testing will occur prior to initial pumping, at the mid-point of the transfer, and at termination of pumping for the transfer. Testing for additional parameters may be necessary depending of the nature of the water quality concerns. The details of any additional testing will be developed cooperatively by the seller and the Review Team and will be applied in an adaptive manner. Selling agencies should submit a planned approach to sampling production wells and a sampling schedule for the monitoring wells. This schedule will indicate the monitoring wells that are to be sampled, the sampling tests to be conducted, the sampling frequency, and the schedule for sampling following the groundwater transfer. A map may also be required, identifying areas of water quality concern within the agency and in neighboring areas that are within proximity to the agency.

Land Subsidence: The extent of monitoring needed to assess effects will depend on the expected susceptibility of the area to land subsidence. Areas in which land subsidence has been documented will require more extensive monitoring than other areas. Alternatively, a plan can rely on maintaining water levels above historic lows thereby minimizing the risk of additional subsidence. The plan will range from periodic determination of elevation in strategic locations throughout the transfer area to installing extensometers and taking readings from them. The plan will include trigger levels requiring action in the event that changes in elevation are detected, as well as provisions for responding to any subsidence detected after cessation of the transfer.

Coordination of Plans: The success of a monitoring program depends on a coordinated means of collecting and organizing the information, in addition to communicating with the well operators and other decision makers. The monitoring plan should identify a contact person responsible for the monitoring and assembly of data. This contact person could be required to meet with a Review Team representative at least two weeks before the start of the groundwater pumping. Together, these parties may visit the monitoring program well sites prior to the start of pumping to measure pre-pumping groundwater levels and to read and inspect flow meters. Those implementing monitoring should attempt to coordinate their efforts with other local monitoring programs. As discussed in 6.2.9.1, coordination with other programs will be facilitated through CALFED's Water Transfer Program.

6.2.7.2.4 Mitigation Program

Objective: The groundwater activities being undertaken by the EWA will be designed to minimize potential environmental impacts through pre-transfer evaluations and the Monitoring Program. In addition, a mitigation program will be required. A number of potential impacts are sufficiently serious that they must be avoided or mitigated for a project to continue. These include:

- Contribution to long-term conditions of overdraft;
- Dewatering or substantially reducing water levels in non-participating wells;
- Measurable land subsidence;
- Degradation of groundwater quality that substantially impairs beneficial uses or violates water quality standards; and
- Affecting the hydrologic regime of wetlands and/or streams to the extent that ecological integrity is impaired.

The previous sections of this document discussed the evaluation process to be used in selecting projects to supply the EWA and the monitoring required for ongoing assessment of the effects of the operating projects. In addition, the following section describes the requirements that a seller develop a mitigation program to address potential impacts.

The mitigation strategy is essentially two-fold. First, the seller will design and implement a monitoring and mitigation plan and will be responsible for mitigating any significant environmental impacts that occur. Second, if the EWA agencies determine that the mitigation undertaken by the seller is inappropriate or ineffective, it will terminate its participation in the project.

Evaluation: Mitigation programs will be tailored to the local conditions within each region. To ensure that each plan meets this objective, the mitigation plan will include the following elements: 1) a procedure for the seller to receive reports of purported environmental or third party effects and to report that information to the Review Team, 2) a procedure for investigating any reported effect, 3) development of mitigation options, in cooperation with the affected third parties, for legitimate effects, 4) assurances that adequate financial resources are available to cover reasonably anticipated mitigation needs, and 5) commitment to avoid or mitigate such effects during future transfers to the EWA.

Information to be Submitted: Sellers will submit a mitigation plan to the Review Team at least one month prior to the groundwater transfer. The following discussion describes the level of detail that the seller must submit in order for the Review Team to determine that a mitigation plan could effectively address mitigation needs.

Reporting to the Review Team. During the transfer, reporting to the Review Team will include data summary tables each month until groundwater levels return to those prior to the start of the pumping. These tables will report the monthly and cumulative quantity pumped, the water level in each well being monitored and any surface water measurements made. In addition, the seller will report any third party effect and its resolution. The seller will prepare and submit a final summary report evaluating the effects of the water transfer program. The final report will include water level contour maps for the subbasin in which the acquisition area is located showing initial water levels, water levels at the end of the transfer, and final recovered water levels.

Response to Reported Impacts. If an effect is identified, the description of the effect and the sellers' proposed response will be submitted to the Review Team. The submittal will include the following: 1) a description of how a formal claim may be made if an impact is suspected, 2) the process to be undertaken to address the claim including if and what type of mitigation measure is necessary, and 3) how the mitigation should be accomplished.

Financial Strategy on Funding Mitigation Measures: Mitigation measures will be locally funded, unless an agreement is made otherwise. Selling agencies will provide assurance that adequate financial resources are available to accomplish any required mitigation.

Commitment to Avoid the Same Impact During Future Transfers: Following investigation, if it is determined that an effect was caused by an EWA groundwater transfer, the seller will be responsible for taking measures to avoid, or effectively mitigate, the same impact in the future, if the seller participates in additional water transfers to the EWA.

6.2.7.3 Groundwater Transfers Near Indian Trust Assets

EWA groundwater transfers may not cause significant adverse effects to nearby Federally reserved Indian Trust Assets. To ensure this, EWA groundwater extraction within 1-2 miles of Indian trust land will require a more detailed pre-purchase groundwater evaluation, which can include estimates of potential interference effects to nearby Indian wells. Before finalizing acquisition contracts, formal consultation will take place between the potentially affected Indian tribe, the willing seller, and appropriate EWA agencies. During this consultation, additional commitments will be developed to further minimize potential effects. Such commitments can include more frequent groundwater monitoring and the discontinuation of EWA groundwater pumping if groundwater levels are drawn down to a level of concern near Federally reserved Indian Trust Assets. The consultation process should ensure that all potential adverse effects are addressed prior to an EWA transfer.

6.2.8 Potentially Significant Unavoidable Impacts

There are no potentially significant unavoidable impacts.

6.2.9 Cumulative Effects

A variety of local and regional programs could cumulatively affect groundwater resources within the next 4 years. The cumulative effects analysis in this EIS/EIR, however, focuses on the regional programs that may affect groundwater rather than local projects. If the cumulative effects resulting from local projects were of concern, this concern would be addressed through the groundwater mitigation measures' pre-purchase evaluation. This section focuses on the potential cumulative effects resulting from larger scale regional programs.

6.2.9.1 Upstream from the Delta Region

Four programs, the Sacramento Valley Water Management Agreement (SVWMA), Dry Year Purchase Program, Environmental Water Program (EWP), and the Drought Risk Reduction Investment Program (DRRIP), could include crop idling as a water acquisition method during dry years. Transfers negotiated between CVP and SWP contractors and other water users, such as the Forbearance Agreement with Westlands WD and the recent crop idling acquisition by Metropolitan WD from water agencies upstream from the Delta, are part of the Dry Year Purchase Program. The above analysis concludes that idling 20 percent of rice or cotton acreage per county would result in less-than-significant effects. As explained in Chapter 11, the EWA agencies would not purchase crop idling water if other reasonably foreseeable transfers from other programs would likely purchase more than 20 percent of rice acreage in that county. Therefore, the above analysis is also consistent for the cumulative effects because the EWA would only purchase water from crop idling in counties where the total of all programs was less than 20 percent of acreage.

Five programs, the SVWMA, Dry Year Purchase Program, EWP, DRRIP, and the Central Valley Improvement Act (CVPIA) Water Acquisition Program, could acquire water via groundwater substitution and groundwater purchase upstream from the Delta. These acquisition programs are described in Chapter 22, Cumulative Effects.

Cumulative effects from these programs would be more likely during dry years than wet years. During wet years, the Dry Year Purchase Program and the DRRIP would most likely not purchase groundwater, and the amount of groundwater that may be purchased by the remaining acquisition programs would be limited because the export pumping capacity is limited. Consequently, the potential for adverse groundwater effects would be less.

In dry years, however, the programs may acquire more groundwater because the pumps would have greater available capacity. The EWA Program, in addition to the SVWMA, Dry Year Purchase Program, and the DRRIP Program, plans to purchase groundwater during dry and critically dry years. The reduction in recharge (due to the decrease in precipitation and runoff) in addition to the increase in groundwater transfers would lower groundwater levels.

Multi-year groundwater acquisition in areas that have repeatedly transferred groundwater may also be more susceptible to adverse effects. In these areas groundwater levels may not fully recover following a transfer and may experience a substantial net decline in groundwater levels over several years.

These cumulative effects could be potentially significant if these programs are not coordinated. It is assumed that each program will institute groundwater mitigation measures similar to those stipulated under the EWA Program. The EWA's groundwater mitigation measures require a pre-purchase evaluation for areas in which groundwater levels (prior to the transfer) are sufficiently low to warrant potential regional adverse effects. (See Section 6.2.7.2.) If the evaluation shows that EWA extraction would likely result in regional adverse effects, the EWA Project Agencies would not purchase groundwater from the area of concern. The groundwater mitigation measures require that the local selling agencies establish monitoring and mitigation programs prior to EWA transfers.

In addition to the monitoring and mitigation stipulations set forth under the EWA groundwater mitigation measures, the SVWMA provides further initiatives to encourage the development of local groundwater management. The local projects focus on surface water/groundwater planning and conjunctive use, including monitoring, areawide inventories and assessments, construction/improvements of conjunctive use facilities, and development of conjunctive use programs. Benefits include 1) improved knowledge of groundwater-surface water interaction, 2) enhanced understanding of groundwater resources and aquifer characteristics, and 3) improved operational flexibility. The additional knowledge and greater flexibility provided by these programs would be beneficial for the understanding of EWA asset acquisition effects (Erlewine 2002). The SVWMA Program would also include monitoring programs in the SVWMA conjunctive use project areas. The initial monitoring in 2003 would focus on identifying potential hydraulic effects. The information acquired from these monitoring programs may be useful for minimizing and/or avoiding the cumulative effects of the acquisition programs mentioned above, further minimizing the potential for cumulative effects. Consequently, the coordinated implementation of these programs together with the mitigation measures stipulated under the EWA Program would minimize any adverse effects that the EWA Program may contribute to the cumulative effects of all the programs to less than significant.

6.2.9.2 Export Service Area

The DRRIP, together with the EWA Program, would also include the option of crop idling south of the Delta. The DRRIP could increase the amount of idled acres if this program and the EWA Program were acquiring water via crop idling at the same time in the same area. Coordination among the asset acquisitions programs would minimize adverse effects, and would be facilitated through CALFED's Water Transfers Program. Also, if the total amount of land idled by all programs, including the EWA, exceeds 20 percent of the county's cotton acreage, the EWA Program would avoid adverse effects by not idling land for that year. Furthermore, due to economic effect considerations, crop idling action would be distributed throughout the agencies, reducing a potential for local groundwater recharge effects due to reduced surface water application to grow crops. Based on this assumption, all potential groundwater recharge effects would be less than significant.

Groundwater purchase and groundwater substitution transfers are components of the DRRIP and the CVPIA Water Acquisition Program. Groundwater purchases for these two programs, in addition to the EWA Program, could result in lower groundwater levels in the Kern County groundwater banks (Section 6.2.4.2). All groundwater purchases must adhere to the local groundwater banking MOUs and agreements discussed in Section 6.2.4.2. These agreements are intended to minimize effects and provide assurances that the local agencies would mitigate effects to less than significant should they occur.

6.3 References

Aikens, Curt. 27 January 2003. (Yuba County Water Agency). Telephone conversation with C. Black of CDM, Sacramento, CA.

Arvin-Edison Water Storage District. 1997. *1997 Agreement Between Arvin-Edison WSD and MWD of Southern California for a Water Management Program.*

Arvin-Edison Water Storage District. 2003. *Arvin-Edison Water Storage District Groundwater Management Plan.* pp. 23-24.

Bair, Lewis. 29 August 2002. (Assistant Manager, Reclamation District 108). Telephone conversation with C. Black of CDM, Sacramento, CA.

Berrenda Mesa Project Participants. 1999. *Memorandum of Understanding Regarding Operation and Monitoring of the Joint Water Banking Project on the Berrenda Mesa Property.* Found in: Exhibit I, Agreement Regarding Joint Water Banking Project on the Berrenda Mesa Property.

Bertoldi, G. L. 1991. *Ground Water in the Central Valley, California – A Summary Report, Regional Aquifer-System Analysis-Central Valley, California*: U.S. Geological Survey, Professional Paper 1401-A.

Biggs-West Gridley Water District. 1995. *Biggs-West Gridley Water District Groundwater Management Plan.*

Board of Supervisors of Butte County. 2002. *Draft Ordinance Amending the County Code, Adding Chapter 33-B, Groundwater Management.*

Board of Supervisors of the County of Tehama. 1994. *Ordinance No. 1617 An Ordinance Repealing, Enacting and Reenacting the Substantive Provisions of Ordinances 1552 and 1553 of the County of Tehama.* Tehama County.

Bucher, Gary. 2 August 2002. (Water Resources Manager, Kern County Water Agency). Meeting with C. Black of CDM, Sacramento, CA.

Butte Basin Water Users Association. 1996. *Development of a Ground-Water Model Butte Basin Area California.* pp. 1-9.

Butte County. 1999. *Chapter 33 Groundwater Conservation.* Sec 33-1 to Sec 33-19.

CALFED. 2000. *Final Programmatic Environmental Impact Statement/Environmental Impact Report.* pp. 5.4-1 to 5.4-14.

California Department of Water Resources. 1982. *State Water Project Recommended Water Management Plan for Tulare Lake Basin Water Storage District in Response to Governor's Executive Order B 68-80*. pp. III-4 to IV-2.

California Department of Water Resources. 1986. *Final Environmental Impact Report, Artificial Recharge, Storage and Overdraft Correction Program,* Kern County.

California Department of Water Resources. 1998. *The California Water Plan Update, Bulletin No. 160-98.*

California Department of Water Resources. 2001. *Interim Department of Water Resources Water Quality Criteria for Acceptance of Non-Project Water into the State Water Project.*

California Department of Water Resources Northern District. 2002. *Sacramento River Basinwide Water Management Plan*.

California Department of Water Resources, Water Transfers Office. 2002. *Draft Water Transfers Papers for Water Transfers in 2002 Involving the Department of Water Resources*.

California Department of Water Resources. 2002. *California's Groundwater Bulletin 118 Update 2002.* Accessed: September 2002. Available from http://www.waterplan.water.ca.gov/groundwater/draftmain2.htm

California Department of Water Resources Northern District. 2003. *Groundwater levels website.* Accessed: 2002 – 2003. Available from http://www.dpla.water.ca.gov/nd/GroundWater/gwlevels.html.

California Department of Water Resources Central District. 2003. *Groundwater levels website.* Accessed: 2002 – 2003. Available from http://www.dpla.water.ca.gov/cd/groundwater/gwlevels.html

CDM. 2001. *Butte County Water Inventory and Analysis*. Report prepared for Butte County Department of Water and Resource Conservation. CDM, Sacramento, CA. pp. 3.1 – 3.4, 3.13 – 3.16, 4.1 –4.27, 4.40.

CH2M Hill, Montgomery Watson, and MBK. 2000. *Sacramento River Settlement Contractors and U.S. Bureau of Reclamation Sacramento River Basinwide Water Management Plan Draft Technical Memorandum No. 2*. pp. 1-51.

CH2M Hill. 2001. *Merced Water Supply Plan Update Final Status Report.* Prepared for City of Merced, Merced Irrigation District, and University of California, Merced. Accessed: May 13, 2002. Available from www.mercedid.org/_images/groundwater_merced.pdf. pp. ES-1 - 2-6.

CH2M Hill. 2001[a]. *The Sacramento Valley Water Management Agreement Short-Term Workplan*.

CH2M Hill. 2001[b]. *Merced ID Proposed Transfer to the EWA*. Report prepared for Marc Van Camp, P.E. (MBK Engineers).

Colusa County. 1999. *Chapter 43 Groundwater Management*. Colusa County. Sec 43-1 – 43-17.

Cotter, Walter. 10 September 2002. (General Manager, Browns Valley Irrigation District). Telephone conversation with C. Black of CDM, Sacramento, CA.

Dudley, Toccoy. 12 December 2002. (Groundwater Section, Chief, California Department of Water Resources Northern Division). Telephone conversation with C. Black of CDM, Sacramento, CA.

EDAW and SWRI. 1999. *Draft Environmental Impact Report for the Water Forum Proposal*. Prepared for Sacramento City-County Office of Metropolitan Water Planning.

Erlewine, Terry. 13 November 2002. (State Water Contractors). Telephone conversation with C. Black of CDM, Sacramento, CA.

Glenn Colusa Irrigation District. 1995. *Glenn Colusa Irrigation District Groundwater Management Plan AB3030*.

Glenn County Board of Supervisors. 1999. Ordinance Amending the County Code, Adding Chapter 20.03 Groundwater Management.

Glenn County Board of Supervisors. 2001. *Basin Management Objective (BMO) For Groundwater Surface Elevations.* pp. A.1-A.9.

Grinnell, Steve. 2 October 2002a. (Consultant to Yuba County Water Agency, Montgomery, Watson, Harza). Telephone conversation with C. Black of CDM, Sacramento, CA.

Grinnell, Steve. 16 October 2002b. (Consultant to Yuba County Water Agency, Montgomery, Watson, Harza). Telephone conversation with C. Black of CDM, Sacramento, CA.

Groundwater Resources Association of California. 2003. *The California Legislative Report.* Accessed: 25 February 2003. Available from http://grac.org/legislation.html.

Iger, Rick. 26 September 2002. (Kern County Water Agency). Telephone conversation with C. Black of CDM, Sacramento, CA.

Kenneth D. Schimdt and Associates. 1996. *Proposed Monitoring Plan for the Kern Fan Element of the Kern Water Bank Draft Report – For Review Purposes Only*. Report prepared for Kern County Water Agency.

Keppen, Dan and Slater, Scott. 1996. *Tehama County Flood Control and Water Conservation District Coordinated AB3030 Groundwater Management Plan.* Report prepared for Tehama County Flood Control and Water Conservation District Board of Directors.

Kern County Water Agency and Berrenda WD. 1992. *Memorandum of Understanding Between Berrenda Mesa Water District and Kern County Water Agency for Developing and Operating a Joint Water Recharge/Recovery Project*.

Kern County Water Agency. 1995a. *Memorandum of Understanding Regarding Operation and Monitoring of the Kern Water Bank Groundwater Banking Program*.

Kern County Water Agency. 1995b. *Joint Powers Agreement for the Kern Water Bank Authority*.

Kern County Water Agency. 1995c. *Proposed Monitoring Plan for the Kern Fan Element of the Kern Water Bank.*

Kern County Water Agency. 1995d. *Memorandum of Understanding Regarding Principles Governing Implementation of the Pioneer Project.* Found in: Appendix C, Initial Study and Proposed Negative Declaration for the Pioneer Groundwater Recharge and Recovery Project.

Kern County Water Agency. 1996a. *Initial Study and Proposed Negative Declaration for the Pioneer Groundwater Recharge and Recovery Project*.

Kern County Water Agency. 1996b. *Agreement with the City of Bakersfield on the Coordinated Operation of Recharge and Recovery Project located on the Kern River Fan.* Agreement Number 06-356.

Kern County Water Agency. 1997. *Standard Scheduling and Payment Provisions for Banking and Recharge Projects.*

Kern County Water Agency. 1998. *Pioneer Project Participation Agreement*.

Kern County Water Agency. 1999. *Agreement Regarding Joint Water Banking Project on the Berrenda Mesa Property*.

Kern County Water Agency. 2000. *Overview of Kern County's Potential to Develop an EWA Water Supply Presented to CALFED Agency Staff*. pp. 8 – 10.

Kern County Water Agency. 2001. *Kern Fan Area Groundwater Recovery Operation and Monitoring Program Draft.*

Kern County Water Agency. 2002. *Water Supply Report 1998*. pp. 3-5, 9 57-58, 74.

Kern Water Bank Authority. 1997. *Monterey Addendum* (which includes Volume IV - NEPA/Federal Endangered Species Act and California Environmental Quality Act/California Endangered species Act compliance Documentation of the Kern Water Bank Habitat Conservation Plan).

Lewis, Steve. 3 October 2002. (Engineer, Arvin-Edison WSD). Telephone conversation with C. Black of CDM, Sacramento, CA.

Lofgren, B.E. 1987. *Land Subsidence in the Davis-Woodland Area, CA in a Proposal to the U.S. Department of Energy for Siting the Super Conducting Super Collider.*

Luhdorff & Scalmanini Consulting Engineers. 2002. *Draft Natomas Area Ground-Water Management Plan, Sacramento and Sutter Counties, CA*. Report prepared for Natomas Central Mutual Water Company. May 2002. pp. 3-25.

Merced County. 1997. *Merced Groundwater Basin Groundwater Management Plan*. Report prepared for Merced County Division of Environmental Health. pp. 1-24.

Merced Irrigation District. 1996. *Merced Irrigation District Groundwater Management Plan*. pp. 1-1 – V-5.

Merced Irrigation District. 2001.*Petition for Temporary Transfer From Merced Irrigation District to the CALFED Environmental Water Account.* Letter to Edward C. Anton, (Chief Division of Water Rights, State Water Resources Control Board).

Montgomery Watson and Harza and CH2M Hill. 2001. *Groundwater Storage Program Construction Grant Application for the American River Basin Regional Conjunctive Use Program. Part C*. Report prepared for Regional Water Authority.

Montgomery Watson Harza. 2002. *One-Year Project for the Sale of Water from the Sacramento Groundwater Authority (SGA) and its Member Agencies to the CALFED Environmental Water Account (EWA) Final Environmental Assessment/Initial Study*. Report prepared for U.S. Bureau of Reclamation.

Natomas Central Mutual Water Company. *Natomas Central Mutual Water Company Conjunctive Use Grant Application* (For CALFED Conjunctive Use Grant Program). Accessed 13 May 2002. Available from http://calfed.ca.gov/adobe_pdf/conjunctive/applications/118.pdf.

Natural Heritage Institute. 2001. *Designing Successful Groundwater Banking Programs in the Central Valley: Lessons from Experience*. pp. 1-48, 71-101.

Page, R. W (U.S. Geological Survey). 1986. *Geology of the Fresh Ground-Water Basin of the Central Valley, California, with Texture Maps and Sections. Regional Aquifer-System Analysis.* U.S. Geological Survey, Professional Paper 1401-C

Richvale Irrigation District. 1995. *Richvale Irrigation District Groundwater Management Plan*.

Sacramento Groundwater Authority. 2001. *Draft Groundwater Management Program*. pp. 1-15.

Selb, Ted. 16 October 2002. (Assistant General Manager, Merced Irrigation District). Telephone conversation with C. Black of CDM, Sacramento, CA.

Semitropic Water Storage District. 1994a. *Semitropic Groundwater Banking Project, Draft Environmental Impact Report*. pp. 6-14 to 6-16, 6-28, 6-29, 6-32.

Semitropic Water Storage District. 1994b. *Memorandum of Understanding between Semitropic Water Storage District and the Adjoining Entities on September 17, 1994.*

Semitropic Water Storage District. 2000a. *Stored Water Recovery Unit, Final Supplemental Environmental Impact Report.*

Semitropic Water Storage District. 2000b. *Stored Water Recovery Unit, Final Supplemental Environmental Impact Report – Findings and Mitigation Monitoring Plan*. pp. 1-2 to 2-6.

Shasta County Water Agency, CH2M Hill, and California Department of Water Resources. 1997. *Shasta County Water Resources Master Plan Phase 1 Report, Current and Future Needs*.

State Water Resources Control Board, Division of Water Rights, California Environmental Protection Agency. 1999. *A Guide to Water Transfers*.

State Water Resources Control Board. 2000. *Plan for Implementing a Comprehensive Program For Monitoring Ambient Surface and Groundwater Quality.* Accessed 26 February 2003. Available from http://www.swrcb.ca.gov/cwphome/land/gama/docs/mp01-2~1.pdf.

Steele, Al. 9 December 2002. (Associate Engineering Geologist, Department of Water Resources Central District). Telephone conversation with C. Black of CDM, Sacramento, CA.

Swearingen, Dee. 27 August 2002. (General Manager, Anderson-Cottonwood Irrigation District). Telephone conversation with C. Black of CDM, Sacramento, CA.

Tulare Lake Water Storage District. 1981. *Report on Irrigation, Drainage and Flooding in the Tulare Lake Basin*. pp. 28, 33, 36.

U.S. Bureau of Reclamation and California Department of Fish and Game. 1990. *A Management Plan for Agricultural Subsurface Drainage and Related Problems on the Westside San Joaquin Valley*. pp. 15-43.

U.S. Bureau of Reclamation. 1997. *Central Valley Project Improvement Act Draft Programmatic Environmental Impact Statement.*

U.S. Bureau of Reclamation. 1999. *Inventory of Groundwater Management Plans, Groundwater Ordinances and Information Relevant to Water Transfers from Selected Central Valley Counties*.

U.S. Bureau of Reclamation. 1999. *Final Environmental Assessment Central Valley Project Improvement Act (CVPIA) Land Retirement Demonstration Project*, Executive Summary.

U.S. Geological Survey. 1983. *Groundwater in the Redding Basin, Shasta and Tehama Counties, CA*. Water-Resources Investigations Report 83-4052.

U.S. Geological Survey. 2002. *Calendar Stream flow Statistics for California*. Accessed: 6 November 2002. Available from http://waterdata.usgs.gov/ca/nwis/annual/calendar_year/?site_no=11270900

Water Forum. 1999. *Water Forum Agreement*. Accessed: 21 May 2002. Available from http://www.waterforum.org/wfaagree.html. pp. 1-7,22-30, 34, 39, 96-106, 241, 245.

Wedemeyer, Eric. 10 September 2002. (Associate Engineer, Shasta County Water Agency). Telephone conversation with C. Black of CDM, Sacramento, CA.

Westlands Water District. 2000. *Land Retirement Demonstration Project 1999 Annual Report*. pp. 60-68.

Williamson, A. K. (U.S. Geological Survey). 1989 *Ground-Water Flow in the Central Valley, California, Regional Aquifer-System Analysis* U.S. Geological Survey, Professional Paper 1401-D.

Yolo County. 1996. *Yolo County Ordinance No. 1195, an Ordinance Adding Chapter 7 to Title 10 of the Yolo County Code Regarding the Extraction and Exportation of Groundwater from Yolo County.*